

JAWS S3 98 Conference

Las Vegas, NV

15-18 June 98

Volume 3

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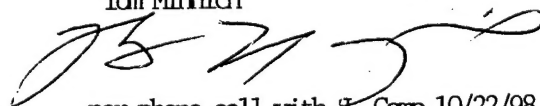
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Tom Mirnich

per phone call with J. Camp 10/22/98
Authorized Signature/Date

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Meeting Technology Needs of the Warfighter...Y2K and Beyond

Trent Thomas
Quantum Research

Bitter Medicine--

● Willy and Ray

Agenda

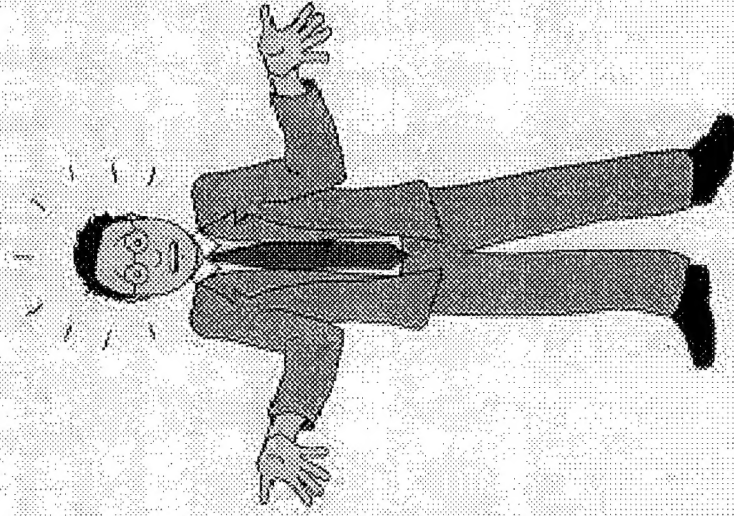
- Introduction
- The Environment
- Conflict
- The Threat
- Technology
- View from the Trenches
- Conclusion

THE ENVIRONMENT

2010 or 1986?

The way we were...

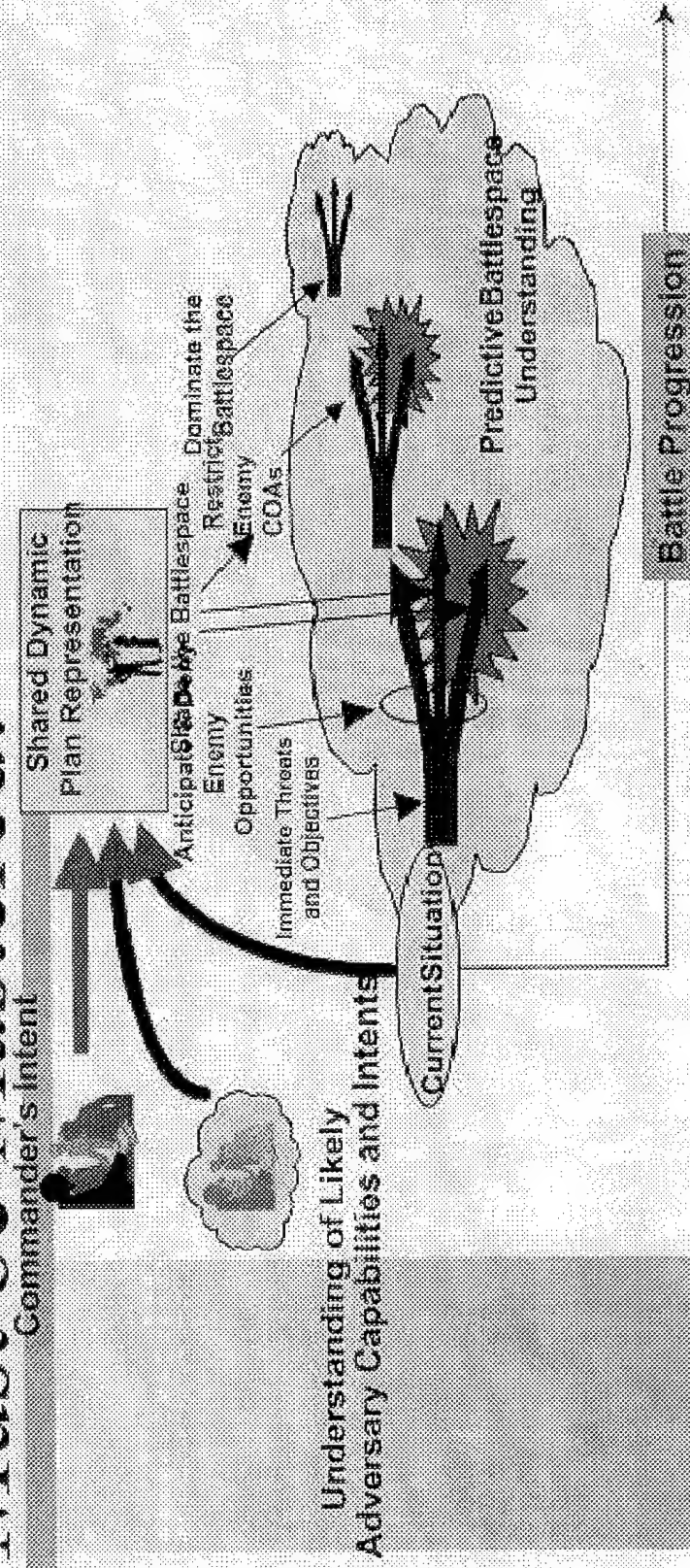
- Me
- My son
- Juanita's Kid



CONFLICT

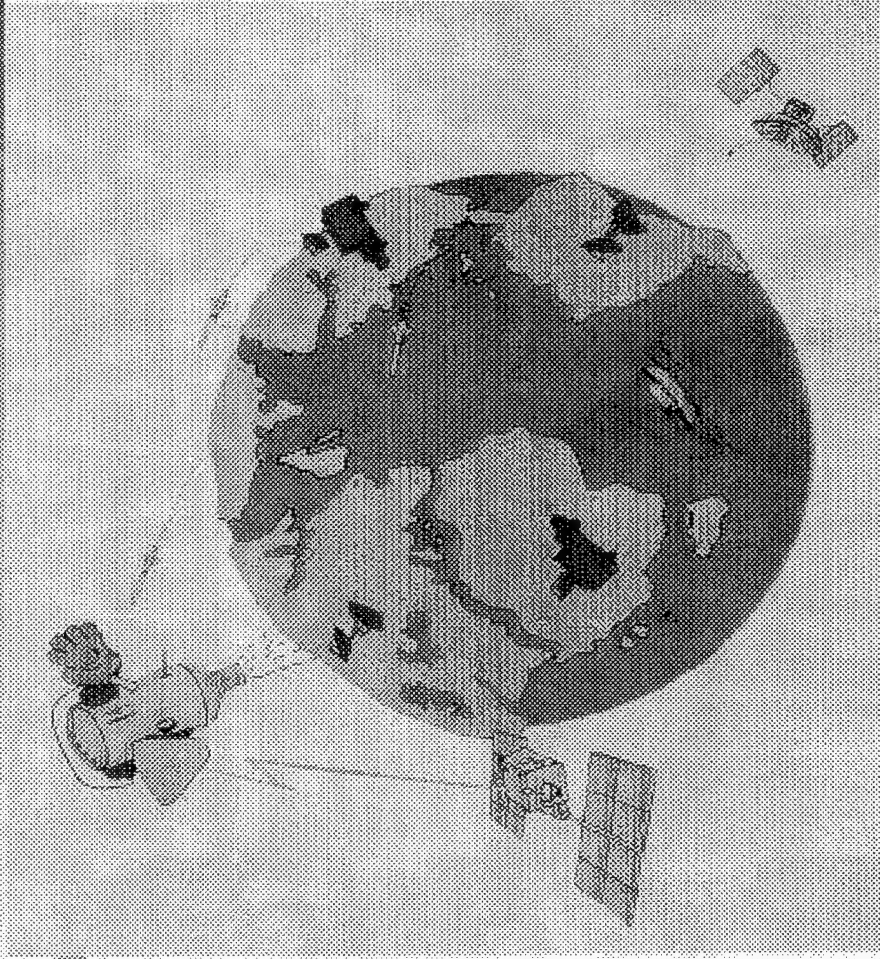
Time—A Dimension that

Must be Mastered!



- Predict and Preempt
- Integrate the Force
- Execute Time-Critical Missions

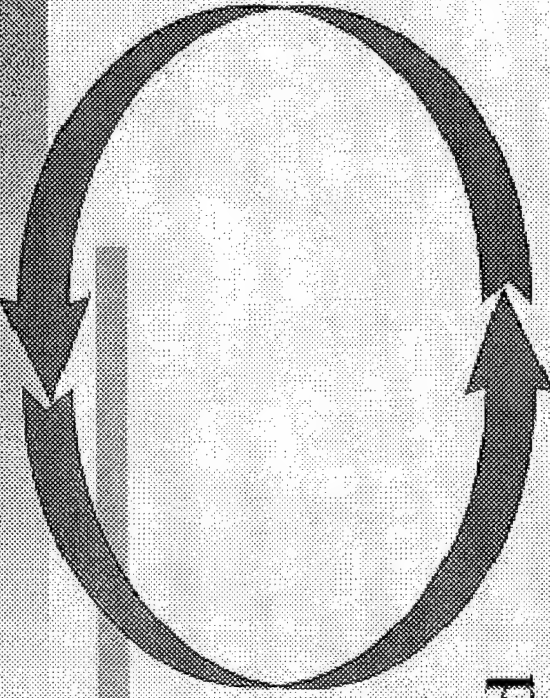
The Expanded Battlespace



Beyond Traditional Physical Dimensions
of Width, Depth, and Height

Conflict

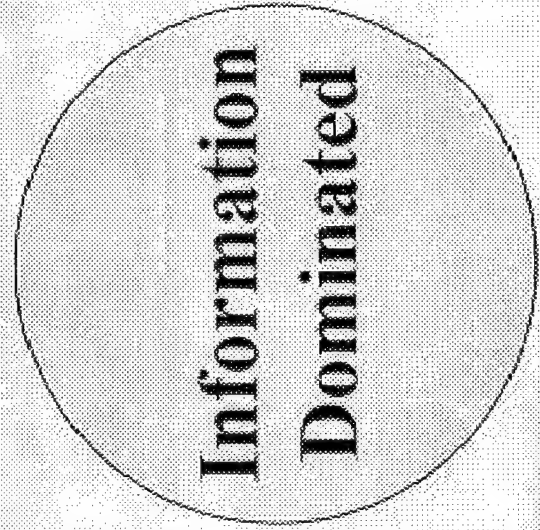
Then:



**Firepower
Dominated**

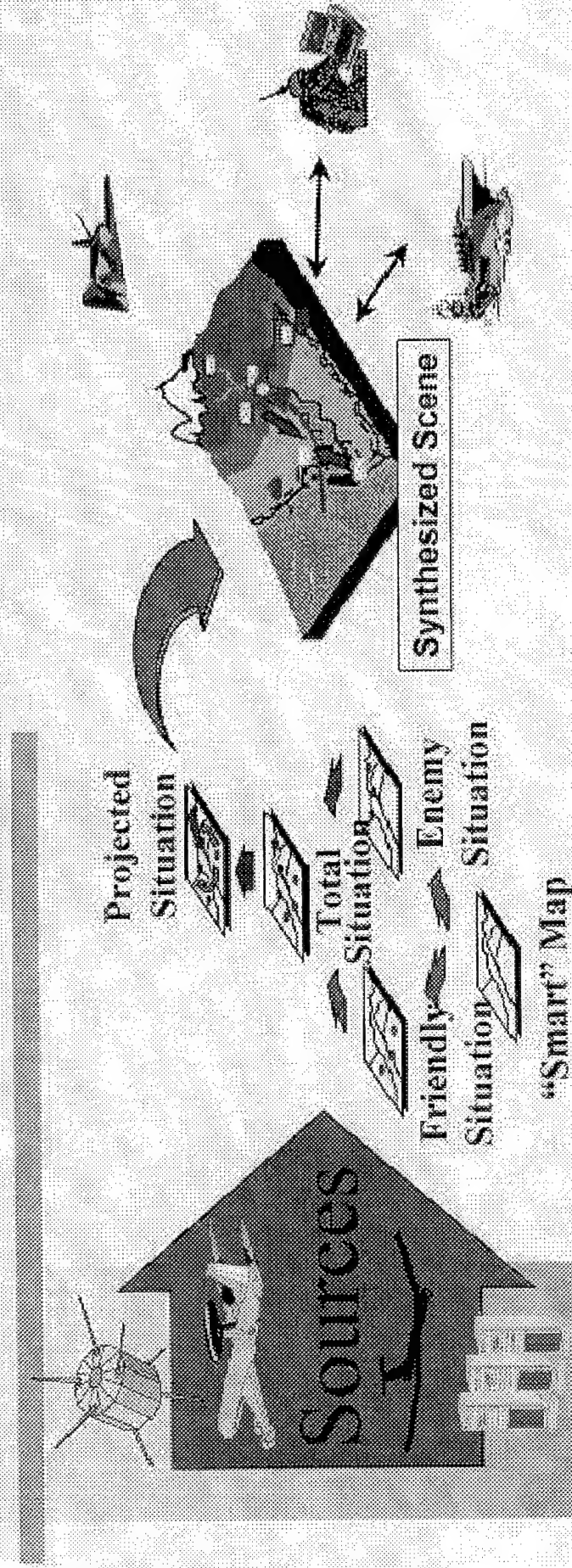
**Maneuver
Dominated**

Soon:



**Information
Dominated**

Information-For Informed Decisions



- Consistent Battlespace Understanding
- Precision Information Direction

THE THREAT

THE SPECTRUM OF CONFLICT

RANGE OF POTENTIAL CONTINGENCIES

MOST LIKELY

LEAST LIKELY

CONFLICTS SHORT OF WAR

MILITARY
ASSISTANCE

COUNTER-
DRUG

COUNTER-
INSURGENCY

TERRORISM

LOCAL
CONVENTIONAL
WAR

REGIONAL
CONVENTIONAL
WAR

GLOBAL
CONVENTIONAL
WAR

LIMITED
NUCLEAR
WAR

GLOBAL
NUCLEAR
WAR

INFRASTRUCTURE WARFARE
INFORMATION OPERATIONS / INFORMATION WARFARE

PEACE OPERATIONS
NATION ASSISTANCE
PEACEKEEPING
OPERATIONS OTHER THAN WAR
OTHER OPERATIONS

ASYMMETRIC
WARFARE

CHEMICAL/BIOLOGICAL
WARFARE

LOW INTENSITY CONFLICT

CRISIS

CONVENTIONAL

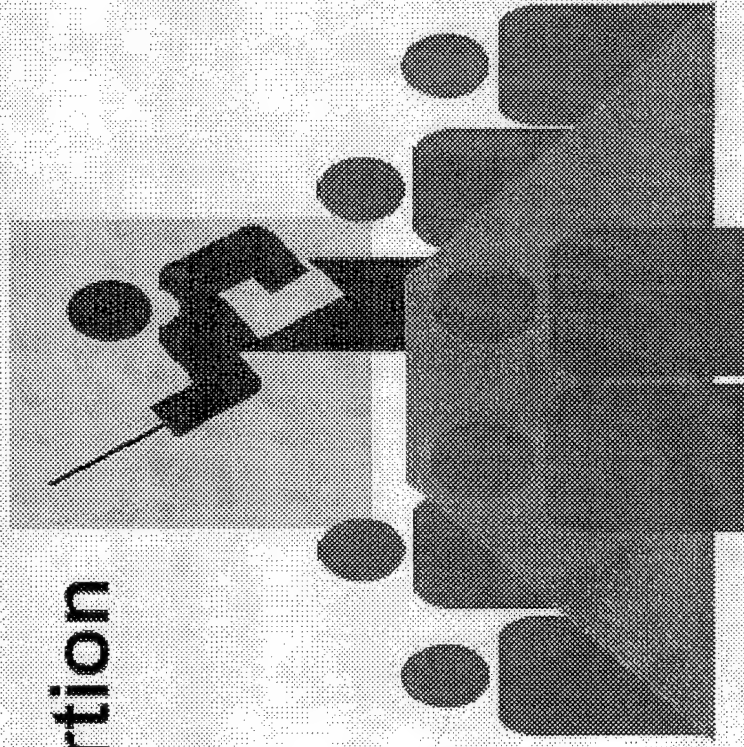
CRITICAL INFRASTRUCTURE PROTECTION

Big Wars/Medium Wars/Small Wars/Non-Wars

- **National Military Strategy**
 - Two, nearly simultaneous conflicts
- **National Military Reality**
 - Somalia
 - Rwanda
 - Haiti
 - Bosnia

Plan for the Future

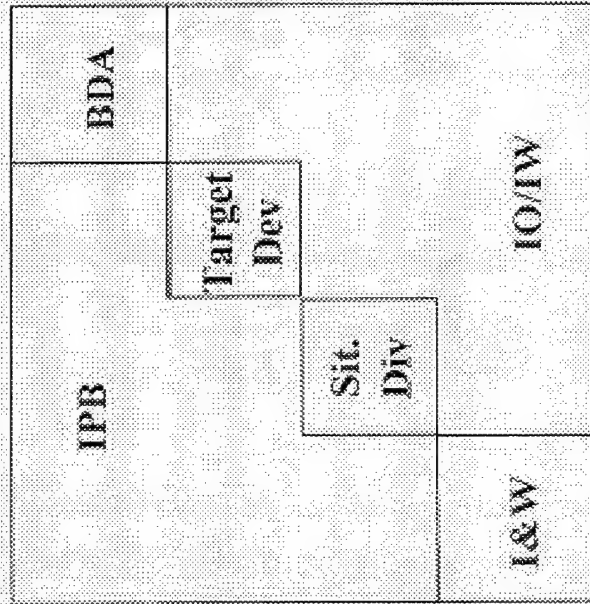
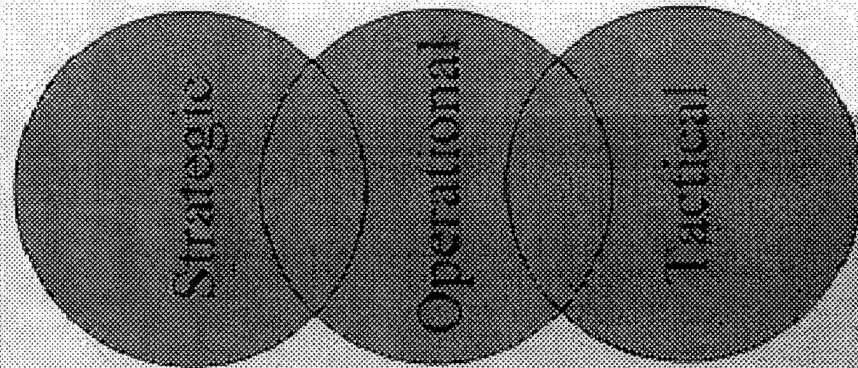
- Joint Vision 2010
- Information Dominance
- Technology Insertion



Force XXI

Begun in 1992, Force XXI is the comprehensive and ongoing modernization process to take the Army to year 2010. The process consists of an interactive and linked series of evaluations, exercises and experiments influencing critical decisions about the Army's future organization, equipment, training and doctrine.

INTELLIGENCE--The Process



Intentions
Capabilities
Organizations/
Nodes
Equipment
Signatures

MTI

CM/CB Radar

SIGINT/MASINT

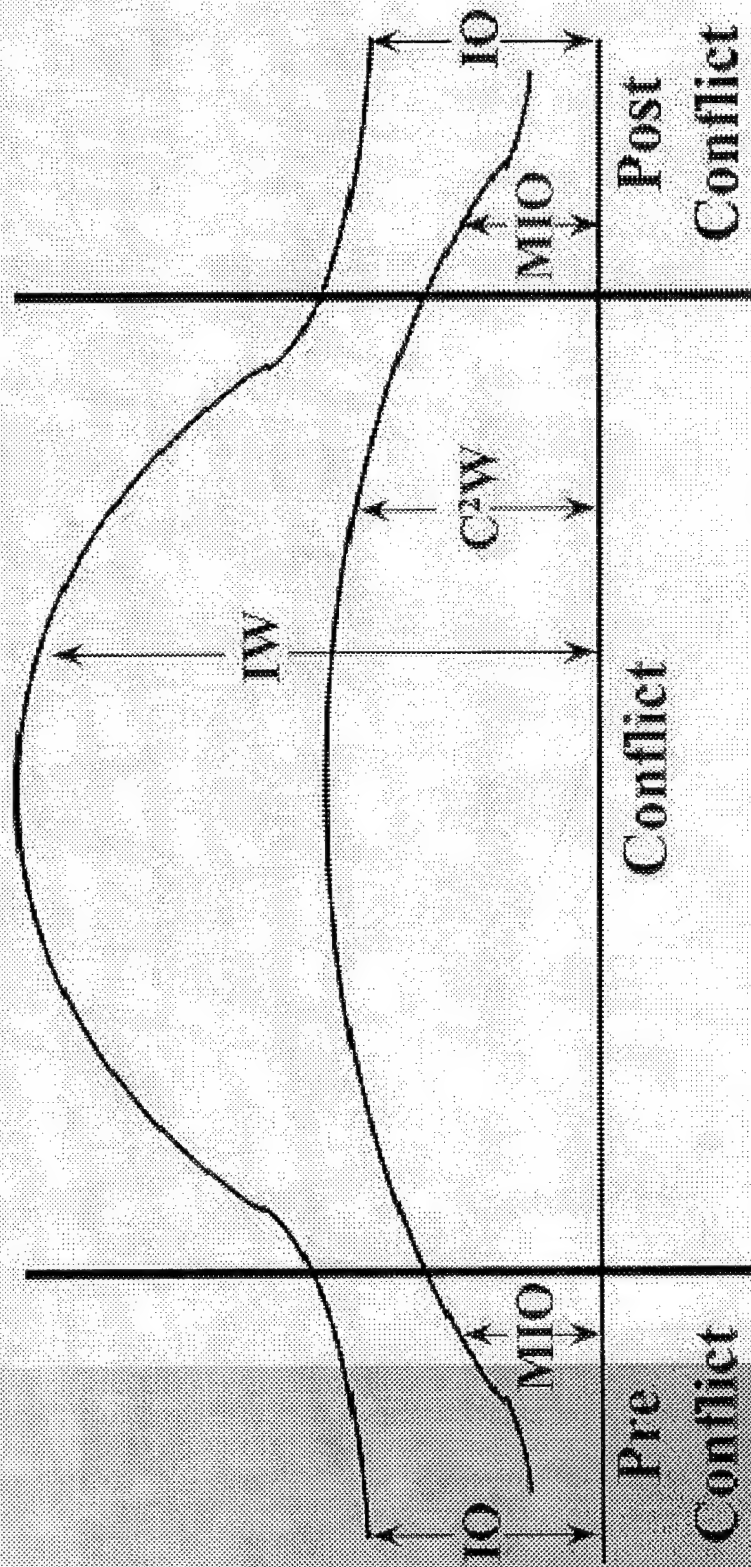
IMINT/HUMINT

Movers

Emitters

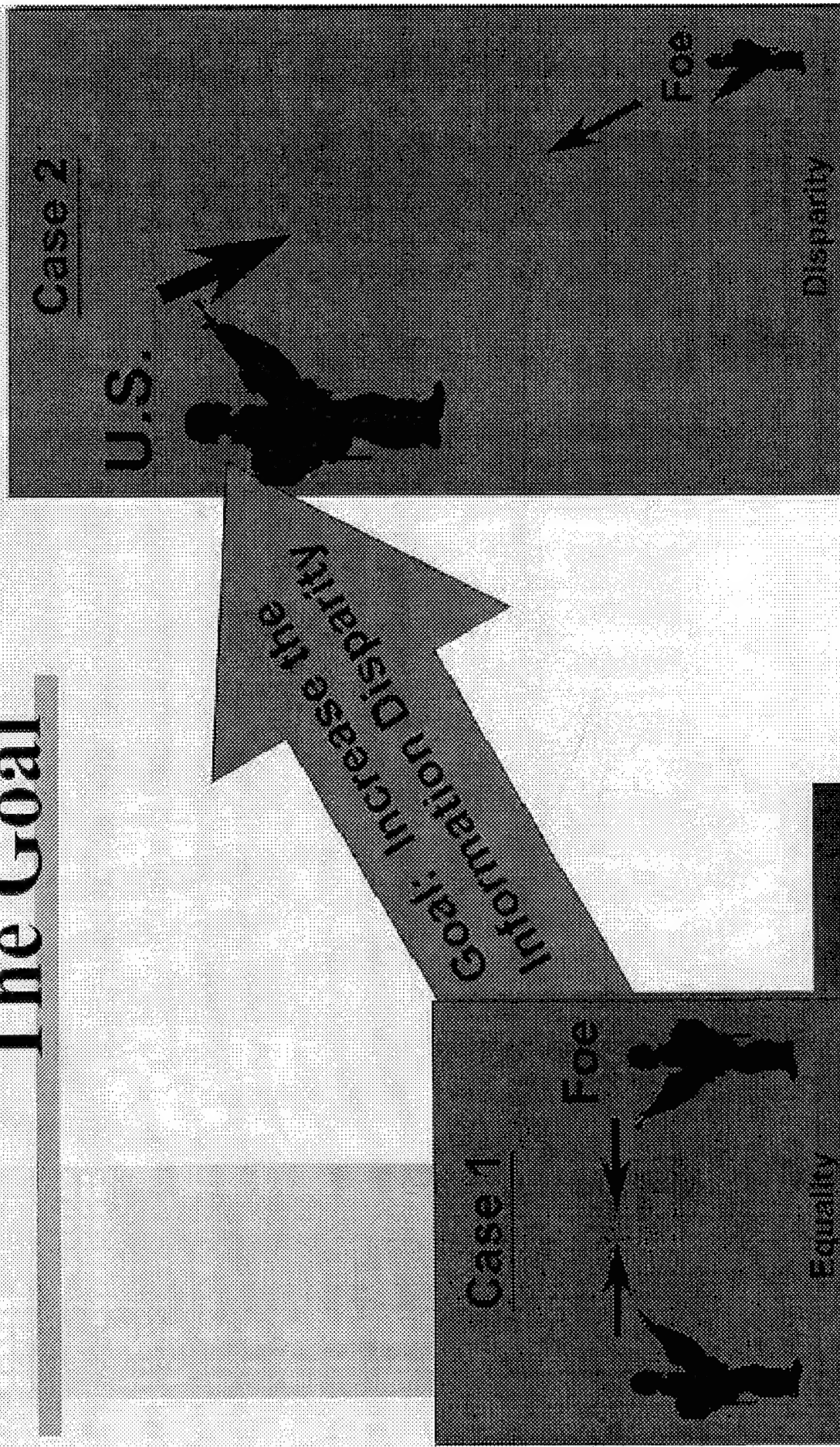
Sitters

Information Warfare/Operations



Information Warfare--

The Goal

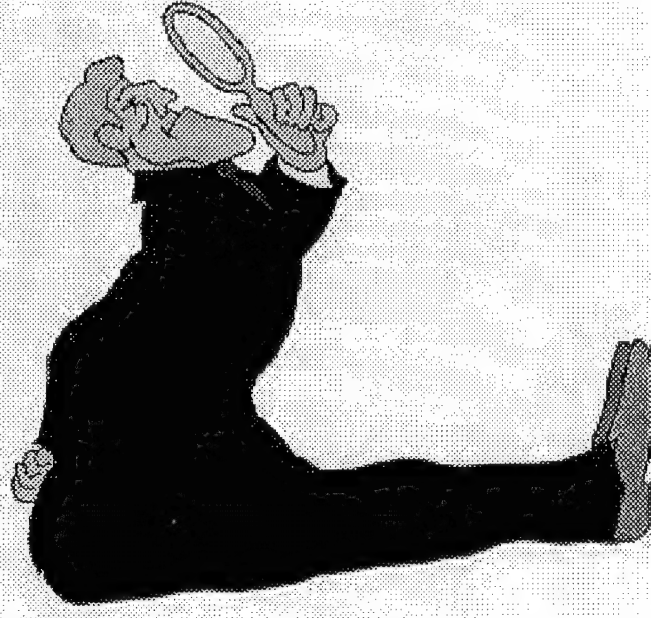


TECHNOLOGY

Technology --Key Question--

What would you do, though now impossible, if possible, that would make warfighting easier?

- See through buildings
- Shoot around corners
- Jump two stories



What We Need--Information Ops

- Improved Blue Force Location Updates
- Rapid Movement of Tailored Information
- Seamless Communication Across All Systems
- Dynamic Network Management
- Red Force Situation—Fidelity; Distribution; Intent; Potential
- Asset Availability: Where; How Much;

When Available

The “Big Eight” Technology Areas

- Universal Transaction Services
- Assurance of Service
- Distributed Environment
- Understanding the Battlespace
- Direct the Information
- Predict and Preempt
- Force Integration
- Execution of Time-Critical Missions



Universal Transaction Services— Needed Technologies

- **Self-Adapting Tactical, Mobile Networking**
- **High-Rate, Asymmetric, Tactical, Mobile Communications**
- **Broadcast with Filtering**
- **Universal Information Transaction Mechanisms**
- **Automated Protocol Language, Syntax, Translation**
- **Condition Information by Compression, Coding, Abstracting**
- **Location-Independent Addressing; Connectivity on Demand**

Assurance of Service— Needed Technologies

- **Information Warfare Surveillance and Defense Tools**
- **Tools for Projecting and Visualizing “Grid” in Operational Terms**
- **Low-Cost Appendages and Shells for Commercial Systems**
- **Anticipatory Services and Management Tools**
- **Multilevel, Adaptive Information Security**

Distributed Environment— Needed Technologies

- Intelligent Agents
- Massive Data Storage and Management
- Geolocation Support
- Heterogeneous Multimedia Conferencing
- Automated Mediators and Database Management Tools
- Automated Language and Syntax Translation

Understanding the Battlespace— Needed Technologies

- Automatic Target Recognition and Battle Damage Assessment
- Multisensor Information Fusion and Sensor Cross Cueing
- Image Understanding and Pattern Recognition
- Recognition, Routing, and Analysis of Data
- Intelligent Agents—Retrieve, Filter, Deconflict
- Agents for Intelligent Inferences
- Real-Time Distributed Object Management
- Uncertainty Management and Visualization

Information Direction— Needed Technologies

- Automatic Target Recognition
- Multisensor Fusion and Cross Cueing
- Automated Battle Damage Assessment
- Intelligent Agents for C4ISR Tasking
- Improved Data and Uncertainty Visualization
- Rapid Modeling and Simulation (M&S) for Sensor Coverage
- M&S for Spectrum Dominance and Information Warfare

Predict and Preempt— Needed Technologies

- **Rapid Modeling and Simulation (M&S) with C3I for Situational Assessment COA**
- **M&S for Mission Preview, Rehearsal, and Training**
- **M&S for Spectrum Dominance and IW Effectiveness**
- **Distributed, Collaborative, Continuous Dynamic Planning**
- **Information Fusion**
- **Automated Nodal Analyses**
- **Adaptive Targeting, Non Pairing and Updates**

Force Integration— Needed Technologies

- Distributed, Collaborative, Dynamic Planning/Scheduling
- Distributed, Collaborative, Virtual Workspaces
- Rapid M&S Including C3I
- Automated Target and Infrastructure ID; Behavior and Change Detection; and Battle Damage Assessment
- Multi-Sensor and Information Fusion
- Search and Text Understanding

Execution of Time-Critical Missions—Needed Technologies

- Multi-Sensor Fusion
- Automatic Target and Infrastructure Recognition
- Automated Intelligence Preparation of the Battlespace (IPB)
- Distributed, Collaborative, Workspace for Intelligence, Surveillance, and Reconnaissance ISR
- Cognitive Displays with Real-Time Presentations
- Decision Support Tools and Automated Planning

VIEW FROM THE TRENCHES

View from the Trenches

Marines

--Switches and dials

--On/Off Switch

--Always On

View (continued)

Army

•Maintenance

--One of kind

--Mixed fleet

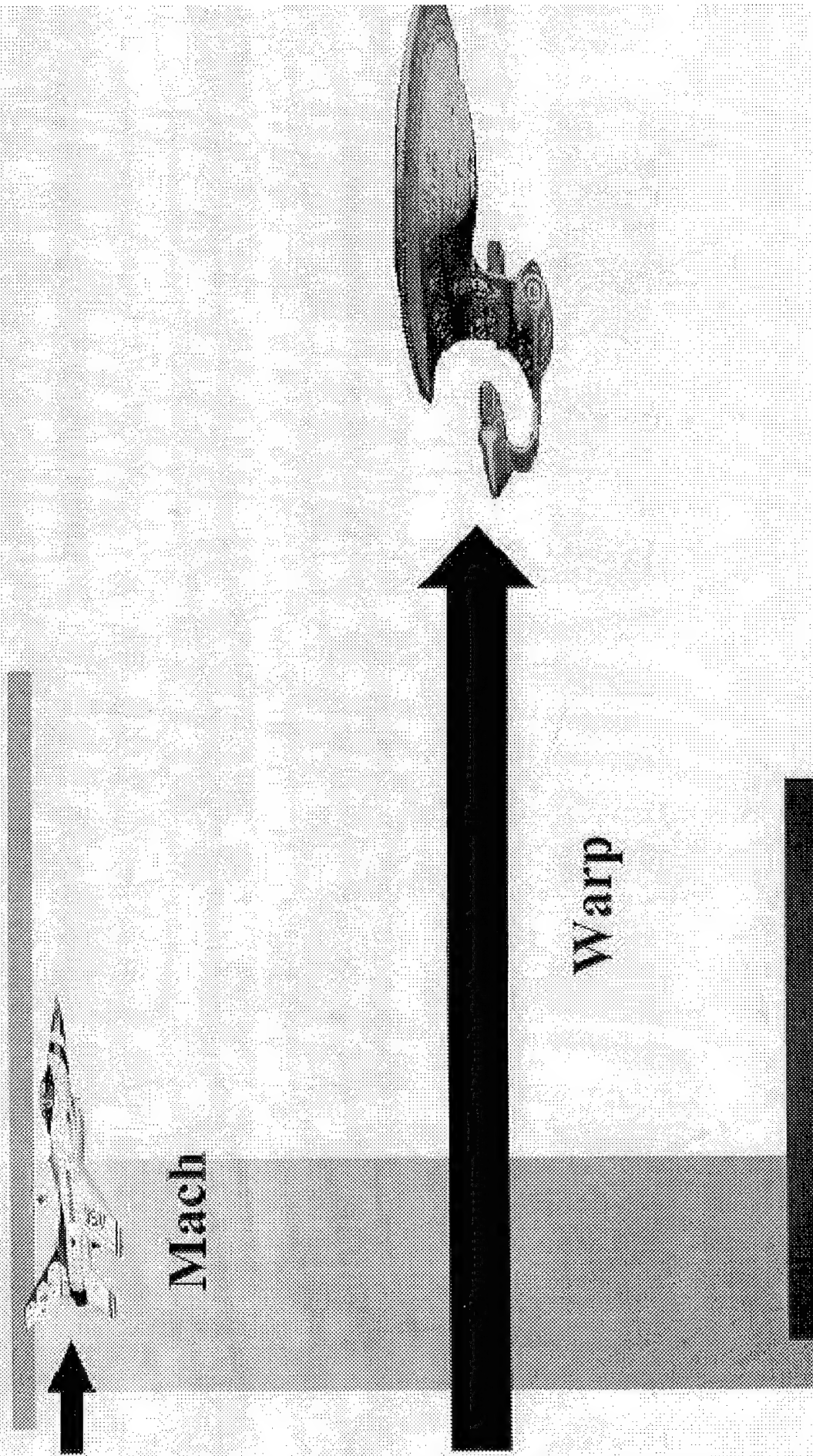
View (continued)

•Technology

--Henry Ford, "Just because you can do something, don't mean you ought to do it."

--'Cost' Counts in a dollar driven world.

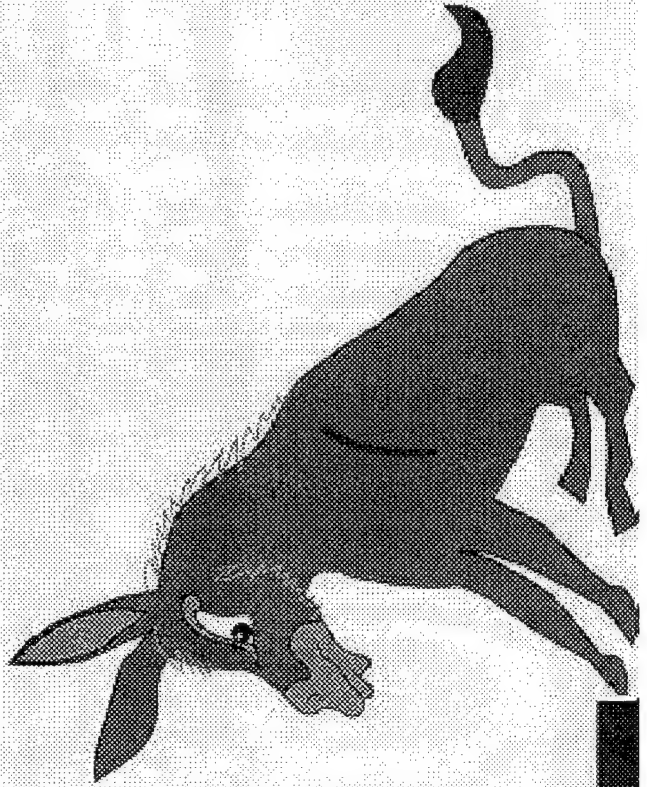
Time Shear



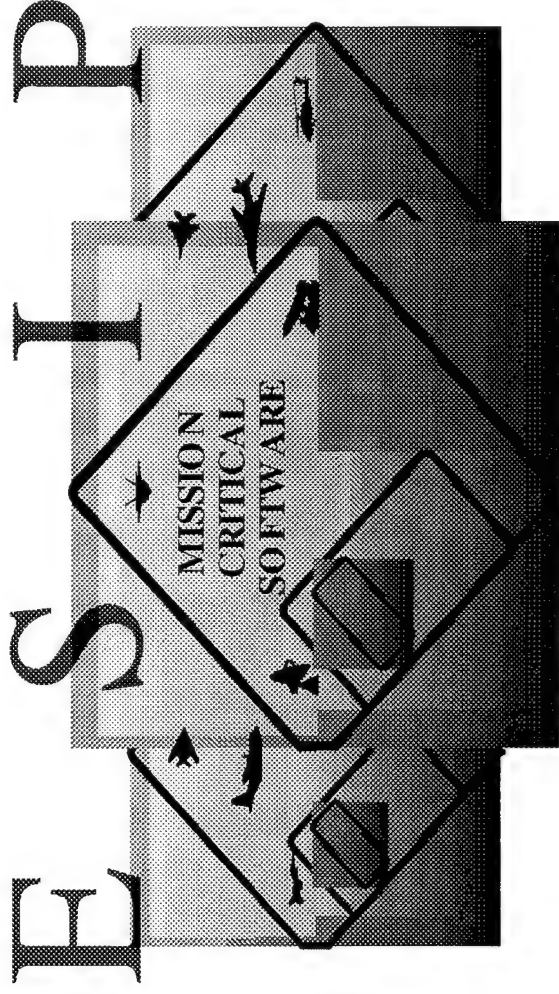
Bitter Medicine--

- Willy and Ray

...but it might be good for you



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Embedded Computer Resources (ECR) Support Improvement Program

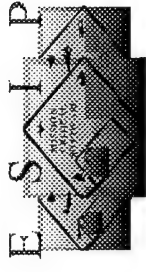
Providing Performance-Based Support

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Fax: (801) 777-9034
Email: jarzombj@software.hill.af.mil
Web Site: <http://esip.hill.af.mil>

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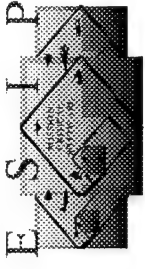
Overview



Relevance to the Software Industry

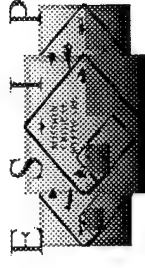
- ◆ Mission & Business Challenges associated with Software
- ◆ ESIP Focus & Support Processes
- ◆ Lessons Learned & Opportunities with ESIP Projects
 - ⇒ AF R&D in conjunction with Commercial Independent R&D
 - ⇒ Software Technology Support
 - Technology Information Services
 - Technology Evaluation & Adoption Services
 - ⇒ Software Readiness
 - Dissemination of Software Best Practices
 - Software Process Improvement Efforts
 - Integration of Measurement Efforts
- ◆ Summary

The Software Challenge

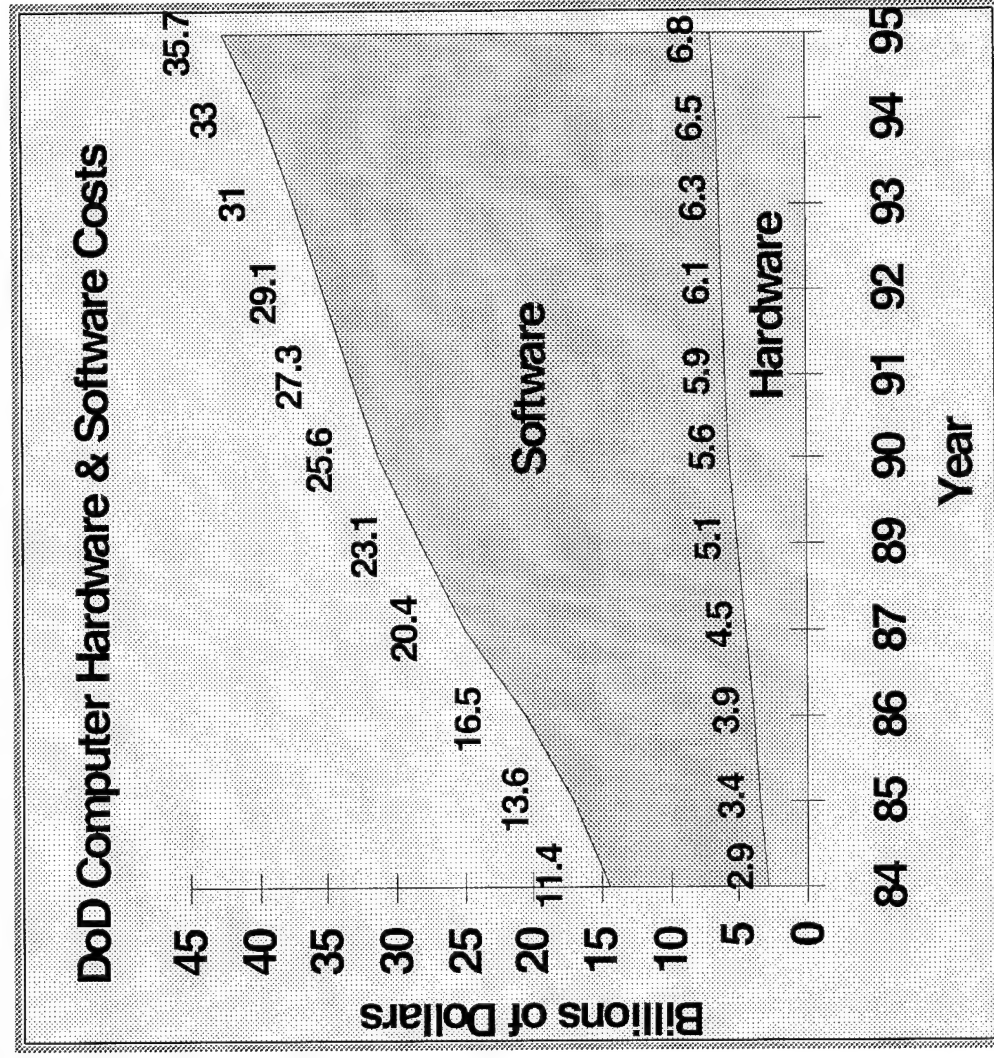


- ◆ By 2002, DoD will spend more than \$20B on s/w
- ◆ Poor Success Rate for Software-Intensive Projects
 - ⇒ 1% of projects are on-time, on-budget & meet expectations
 - ⇒ 33% software-intensive projects never finish
- ◆ Unacceptable Schedule Variance
 - ⇒ Average is 1 Year Behind Schedule
 - ⇒ Average Schedule Missed by 50%
- ◆ 75% are “Operational Failures”

National Security Systems Challenges

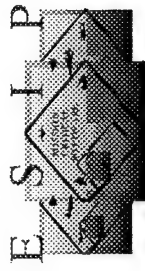


- The quantity of software in weapon systems is increasing dramatically
- Software provides increased system capability & flexibility
- Increases in program schedules & cost (both in acquisition & sustainment) prompt need for software solutions in Information Technology (IT) in National Security Systems (NSS = MCCR)

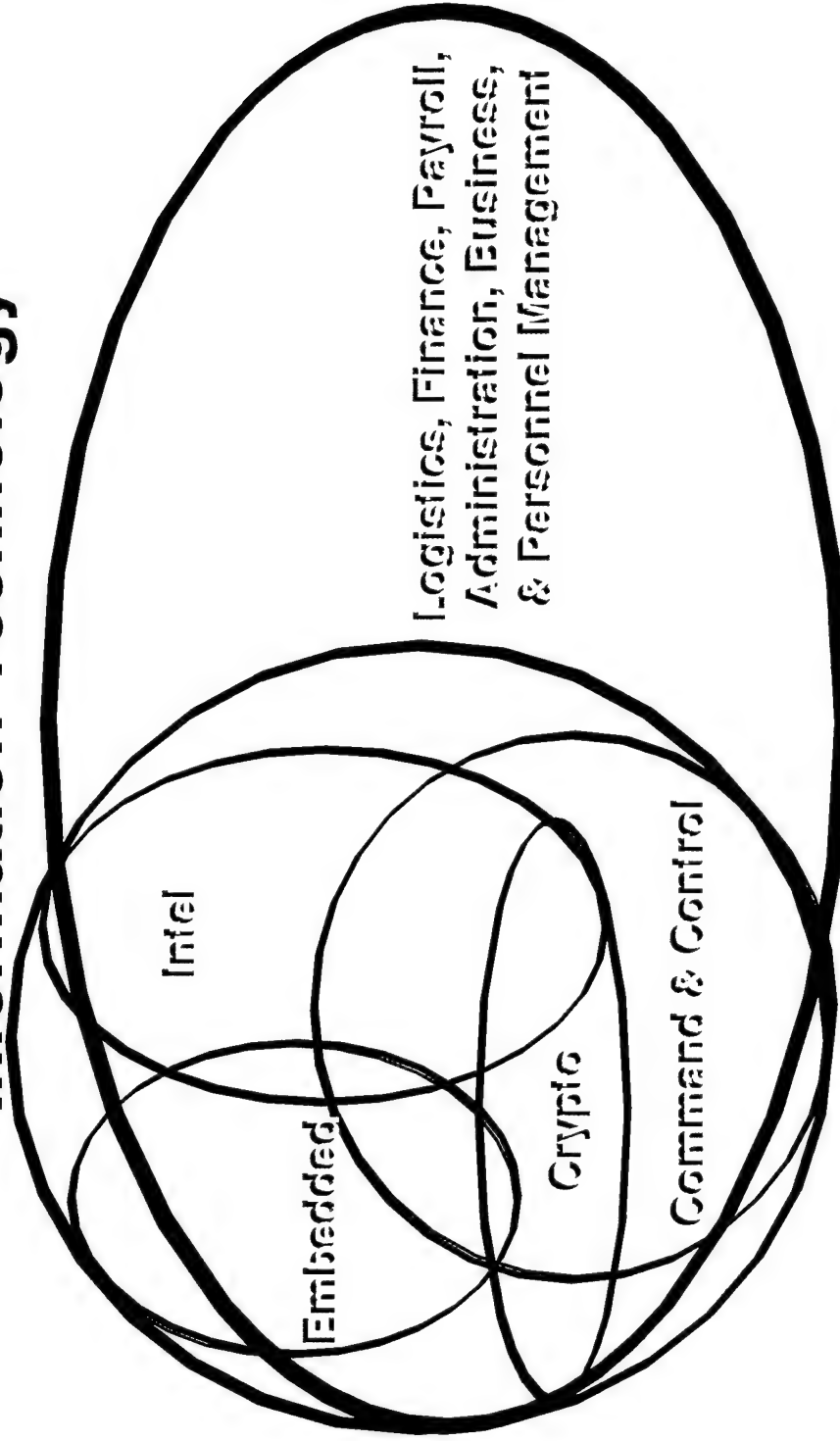


ESIP Focus -

Mission Critical Software for IT

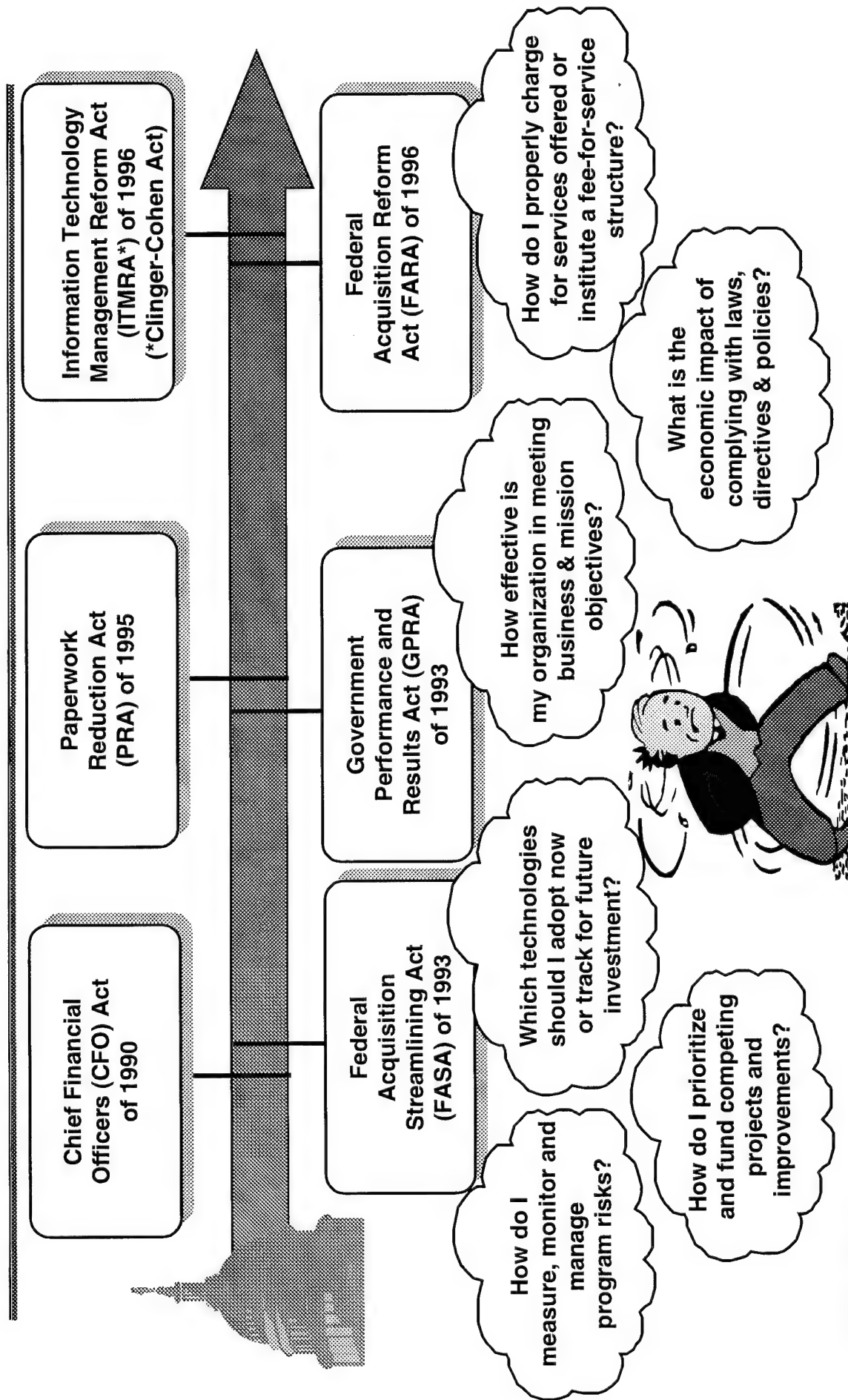
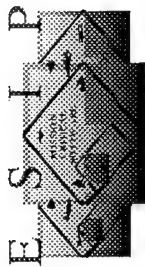


Information Technology



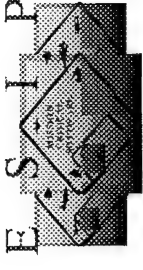
ITMRA & DoD Directive 8000.1 define IT National Security Systems (NSS = MCCR)
Mission Critical Computer Resources = C2, Crypto, Intel & Embedded Systems

Coping with Business Challenges & Need for Performance Improvement



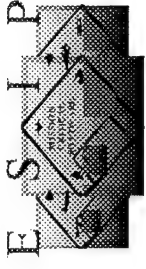
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Coping with DoD Business Challenges

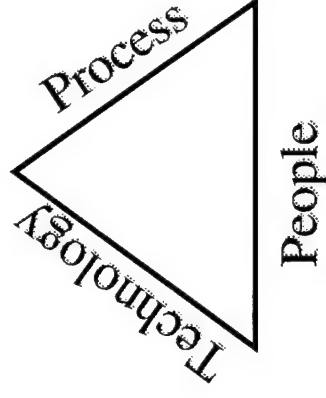


- ◆ OMB guidance and DoD Directive 8000.1
 - ⇒ place more demands for performance-based & results-based management processes and tools
 - ⇒ guide Information Technology (IT) program expenditures to ensure they provide measurable improvements to mission performance
- ◆ Acquisition workforce downsizing & demand for outsourcing
 - ⇒ causes shortage of critical technical expertise in program office staffs
 - ⇒ creates need for more acquisition expertise in non-acquisition staffs
- ◆ Audit agencies scrutinize program offices' capability maturity
 - ⇒ GAO recognizes software's growing importance/prevalence
 - ⇒ Program offices' software acquisition processes reviewed in audits

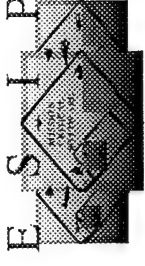
ESIP Support Role in Managing Software-Intensive Systems



- ◆ **PM focus for development, acquisition & sustainment**
 - ⇒ More complex responsibilities associated with risk management
 - Outsourcing reduces direct control; retains execution responsibilities
 - Reliance on COTS capabilities increases risks with program insight
 - ⇒ More demand & need to use program measurements
 - ⇒ More need for enterprise-wide process improvement
 - ⇒ More direct user influence on resource allocation
- ◆ **Need for strategic alliances to match needs of various programs with appropriate providers**



ESIP Support Role



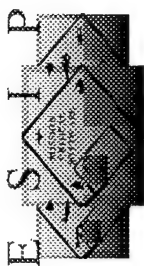
ESIP PMD 3118 / PE 78611

Mission

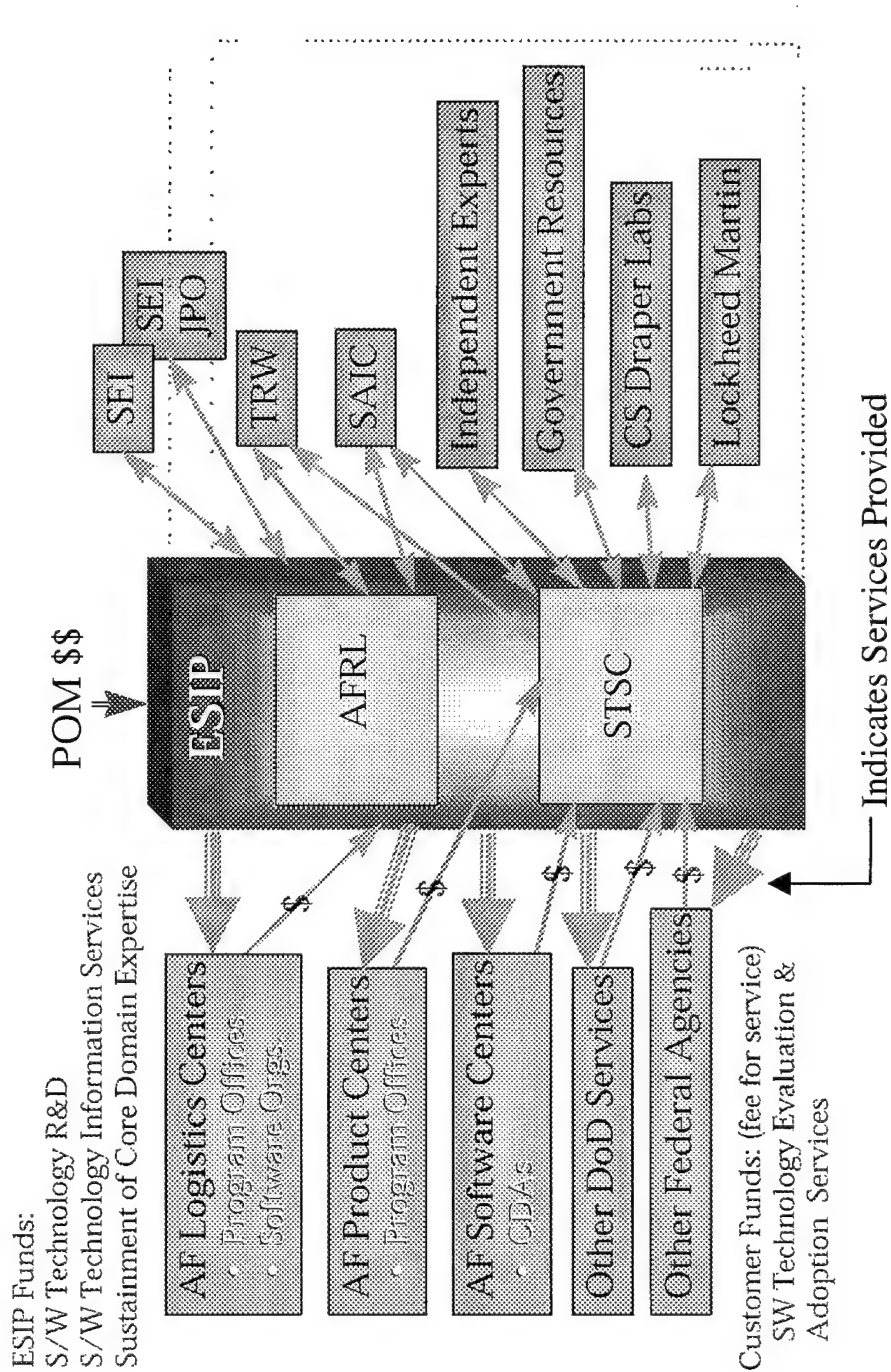
- Provide an infrastructure to **identify, develop, and transition effective technologies** to software organizations to enhance their ability to develop, acquire, manage, test, and support mission critical software in National Security Systems.
- **Facilitate the fielding of affordable, reliable, sustainable, technologically superior weapon and support systems** through the efficient use of limited resources.
- For the **adoption of effective technologies**, ESIP provides:
 - Information & engineering services
 - Hardware & software procurement
 - Research & development services

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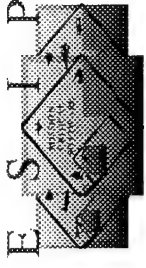
ESIP Support Role



ESIP Virtual Program Office Support to Customers



ESIP Support Role

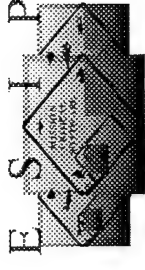


ESIP Role in the Technology Maturization Process



ESIP PMD Task #2

Research & Development



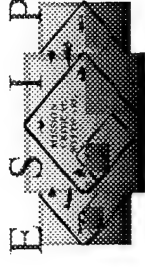
♦ **Develop/demonstrate support concepts & systems**

- ⇒ Environment for real-time testing & support
- ⇒ Integrated performance monitoring & control systems
- ⇒ Test/Data reduction methodologies & tools
- ⇒ Fault tolerant systems & complex systems diagnostics
- ⇒ Software instrumentation
- ⇒ Legacy System Migration
- ⇒ Readiness/rapid reprogramming methodologies

♦ **Transition successful prototypes for application by AF mission-critical software support organizations**

- ⇒ Focus on common, multi-user software problems
- ⇒ Apply technology across platforms and organizations
- ⇒ Team with industry to build and evolve best technologies

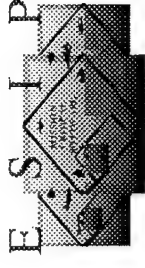
ESIP R&D Value/ROI



ESIP-SPONSORED PROJECTS PRODUCE HALF OF AF RESEARCH LAB AVIONICS SUCCESS STORIES

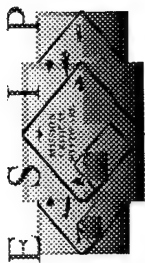
- ◆ 3 to 1 Customer Funding to ESIP Funding
- ◆ 10 to 1 Cost Avoidance to ESIP Funding
- ◆ 100 to 1 Cost Avoidance to ESIP Funding
for fully commercialized technology
- Software enhancements/fixes operational more rapidly
- Dramatic increases in software mission effectiveness
- Increased capability to meet evolving mission critical software demands
- Companies have collaborative opportunities for IR&D

Example R&D Project Meeting a Need

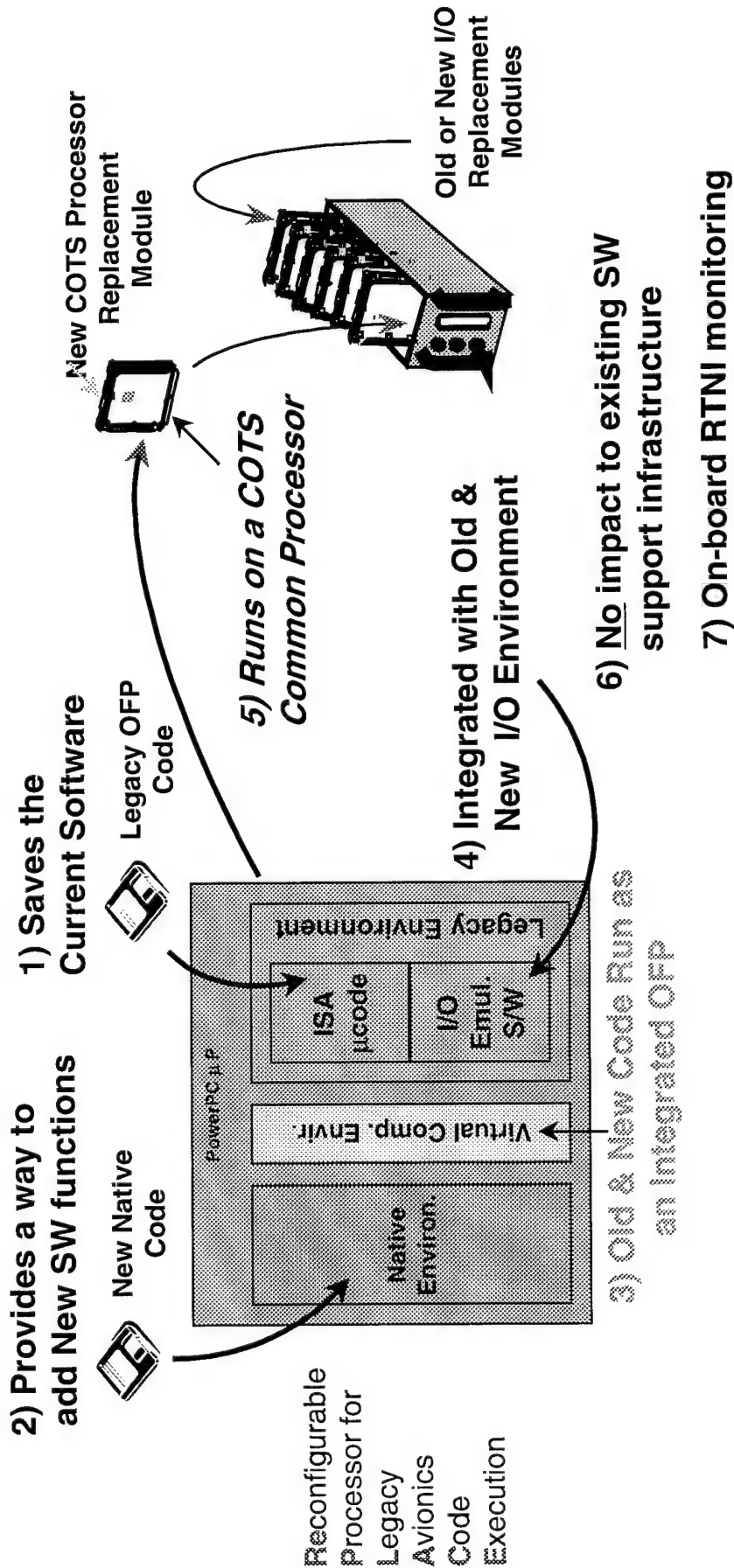


- ◆ Need: Force structure is budget driven; reliant on legacy systems
 - ⇒ New procurements reduced;
 - ⇒ Most 2010 systems in inventory today; older systems to pick up the slack
- ◆ Existing software-intensive systems need improvements to:
 - ⇒ Solve parts obsolescence problems
 - ⇒ Meet new/changing mission requirements
 - ⇒ Keep mission capabilities operating longer at reduced cost
- ◆ What can be done?
 - ⇒ Change hardware (capitalize on technology advances; replace obsolete embedded computers)
 - ⇒ But save the legacy software (preserve original investment; establish known, good starting point)
 - ⇒ And incrementally add capability (rapid deployment, managed change; use modern object-based software architectures)

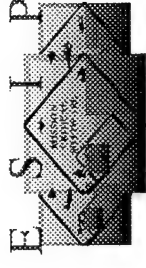
Reconfigurable Processor for Legacy Avionics Code Execution (RePLACE)[™] done with TRW IR&D



- ◆ **Situation Case :** Service life extension of DOD software-intensive systems
- ◆ **Case Impact:** Aging systems - parts obsolescence & performance limitations
- ◆ **R&D Objective:** A cost effective, lower risk approach to system upgrades
- ◆ **R&D Focus:** Develop a software based technology that:



Reasons for Considering RePLACE™

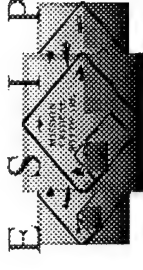


- ◆ Lowers NRE for legacy processor upgrades
 - ⇒ Reuse of existing software (preserve original investment)
 - ⇒ Establish known good starting point for managed software upgrades
 - ⇒ Reduces need for much regression testing
- ◆ Lowers Sustainment Cost
 - ⇒ Takes advantage of COTS-based, open systems hardware
 - ⇒ Modern software development environment
 - ⇒ Better software/system diagnostics through real-time, non-intrusive monitoring (dramatically enhances testability/supportability of the hardware and embedded software)
 - ⇒ Enables affordable approach to performance enhancements
- ◆ Licensed tool available; easily used by organizations

*See RePLACE presentation in JAWS Software & Information (SI)
Technology Focus Group on Thursday, 18 June at 1300 hrs*

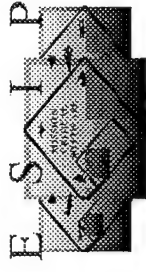
ESIP PMD Task #3

Software Technology Support (STS)

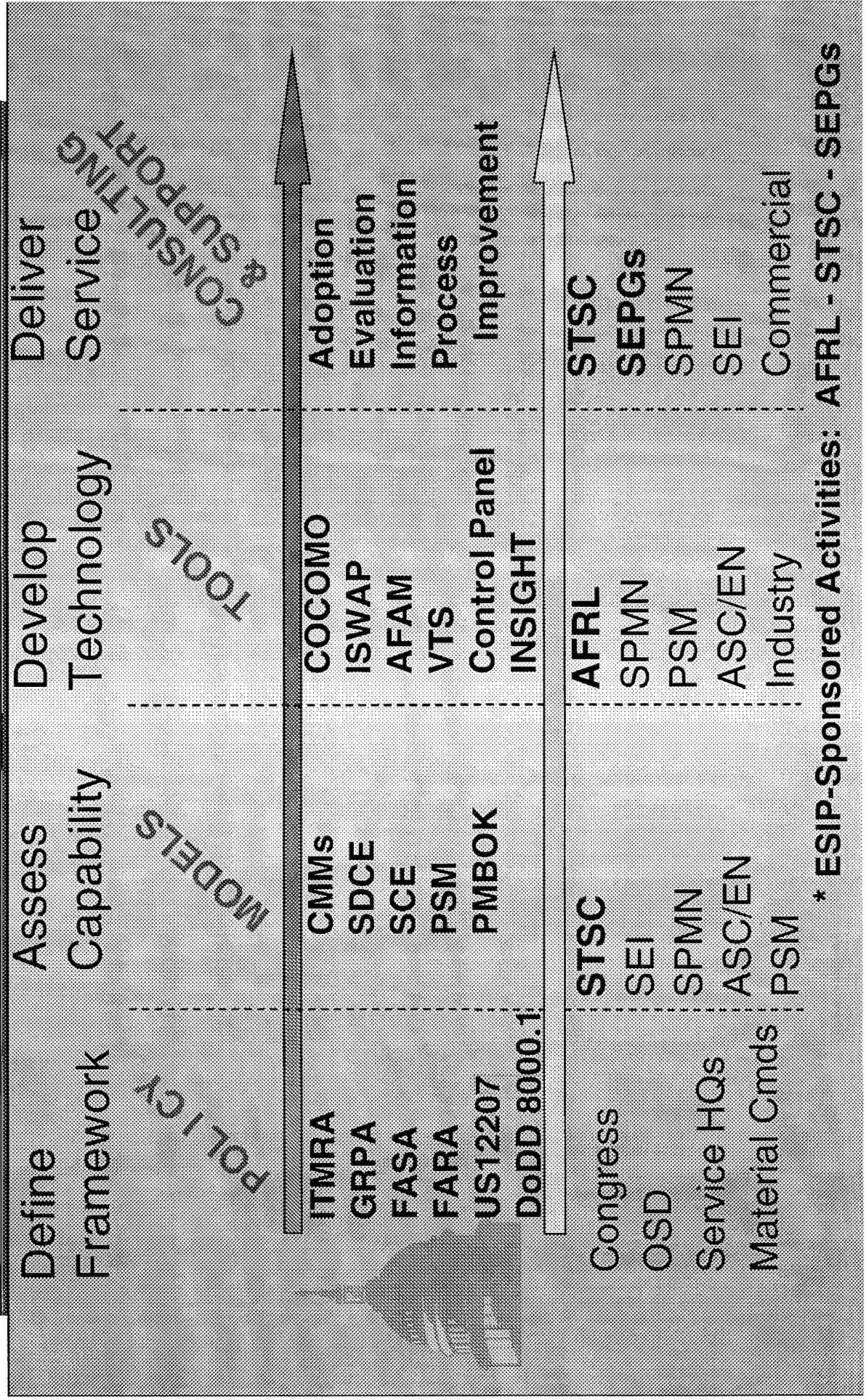


Provide Software Technology Support Center (STSC) to perform:

- ◆ Technology Information Services
- ◆ Technology Evaluation Services
- ◆ Technology Adoption Services & Support Processes

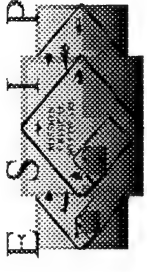


Software Technology Support Approach

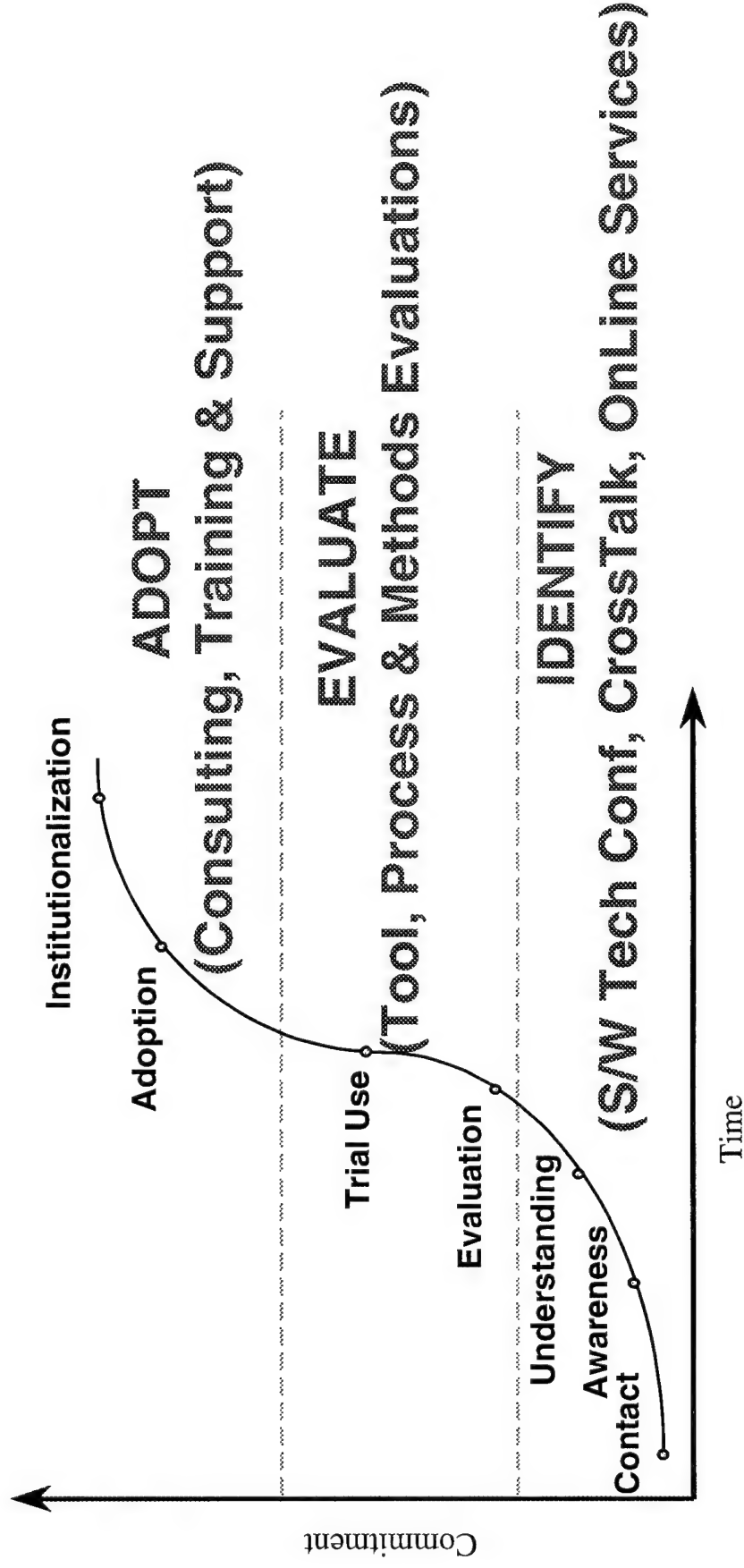


ESIP PMD Task 3:

Software Technology Support (STS)

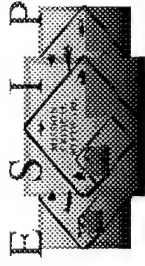


STS Center (STSC) helps organizations improve their software development, acquisition & sustainment efforts.



ESIP

Technology Information Services



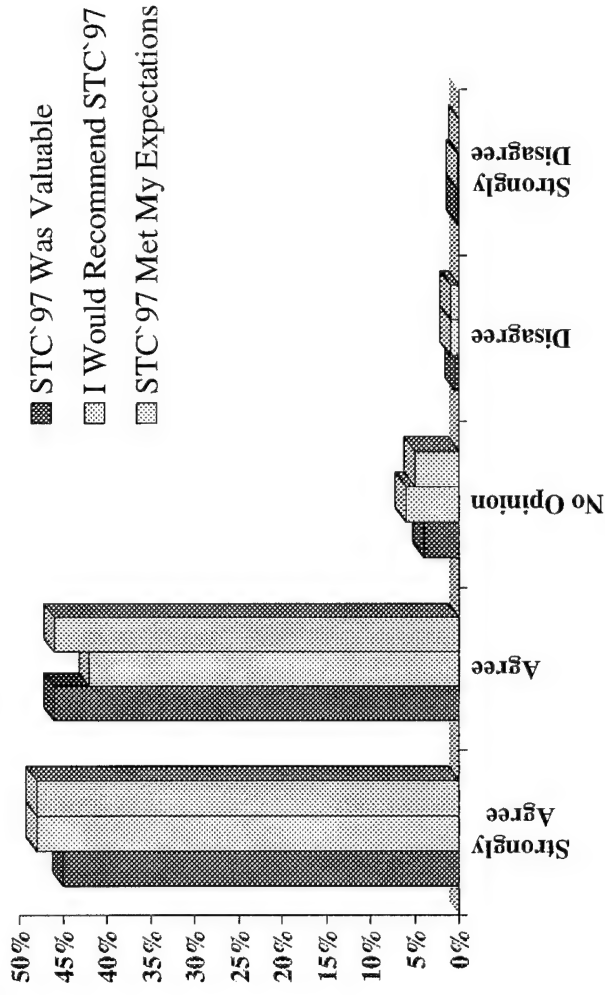
Software Technology Conference (STC)

◆ Responsive to DoD Software Community:

- ⇒ Focused on Practical Solutions and Geared to Government Needs
- ⇒ Co-sponsored by All Military Services & DISA
- ⇒ STC '97 & STC '98 had a 92% Approval Rating
- ⇒ Over 3300 participants for last two

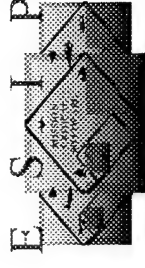
◆ STC '98:

- ⇒ Theme: Knowledge Sharing--
Global Information Networks
- ⇒ 20-23 Apr 98 in SLC, UT
- ⇒ <http://www.stc98.org>
- ⇒ 10 tracks & 3 exhibitor tracks,
including a JAWS S3 Track



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Technology Information Services

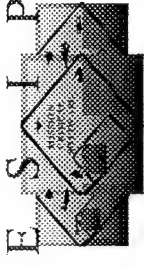


CrossTalk

The Journal of Defense Software Engineering

- ◆ Inform & Educate the Defense Software Community
 - ⇧ DoD Software Policy
 - ⇧ Software Engineering Technology
 - ⇧ Field Experience and Lessons Learned
- ◆ Increase Awareness of Successful Technologies
- ◆ Readers report gaining applied ideas
 - ⇧ 54% report gaining 2-3 good ideas applied to their projects
 - ⇧ 38% report 4 -10 good ideas applied to their projects
- ◆ 19,000 Hard-Copy Subscribers
- ◆ Average of 12,000 Hits On-Line per Month

Technology Information Services

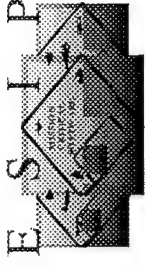


Software Technology Reports

- ◆ Tech Reports provided by the STSC:
 - ⇒ vital products of Software Technology Evaluation efforts
 - ⇒ to consistently reflect the “state of practice”
 - ⇒ to reflect changes in Federal, DoD & AF guidance
- ◆ Tech Reports cover broad range of s/w technology
 - ⇒ Systems Engineering & Development and CMMI
 - ⇒ Program Management & Software Acquisition
 - ⇒ Reengineering and Y2K support
 - ⇒ Metrics & Measurement support
 - ⇒ Client/Server/Process

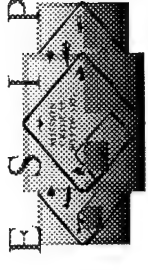
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Technology Evaluation Services

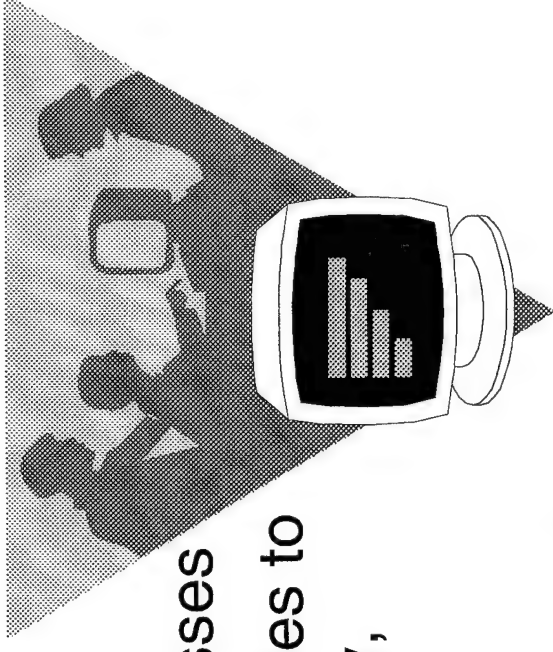


- ◆ Help organizations identify, assimilate, pare down, evaluate & select proven technologies
- ◆ Research, classify, validate, demonstrate, evaluate, analyze, compare & recommend technologies to improve production quality, efficiency or predictability
- ◆ Provide evaluation services and reports for:
 - ⇒ Integrated Environments & Object-Oriented Development
 - ⇒ Reuse, High Order Languages, and Reengineering
 - ⇒ Project Management, Configuration Management, & Documentation
 - ⇒ Process Definition, Requirements Engineering, & Software Design
 - ⇒ Software Measures/Metrics, Quality Engineering & Testing

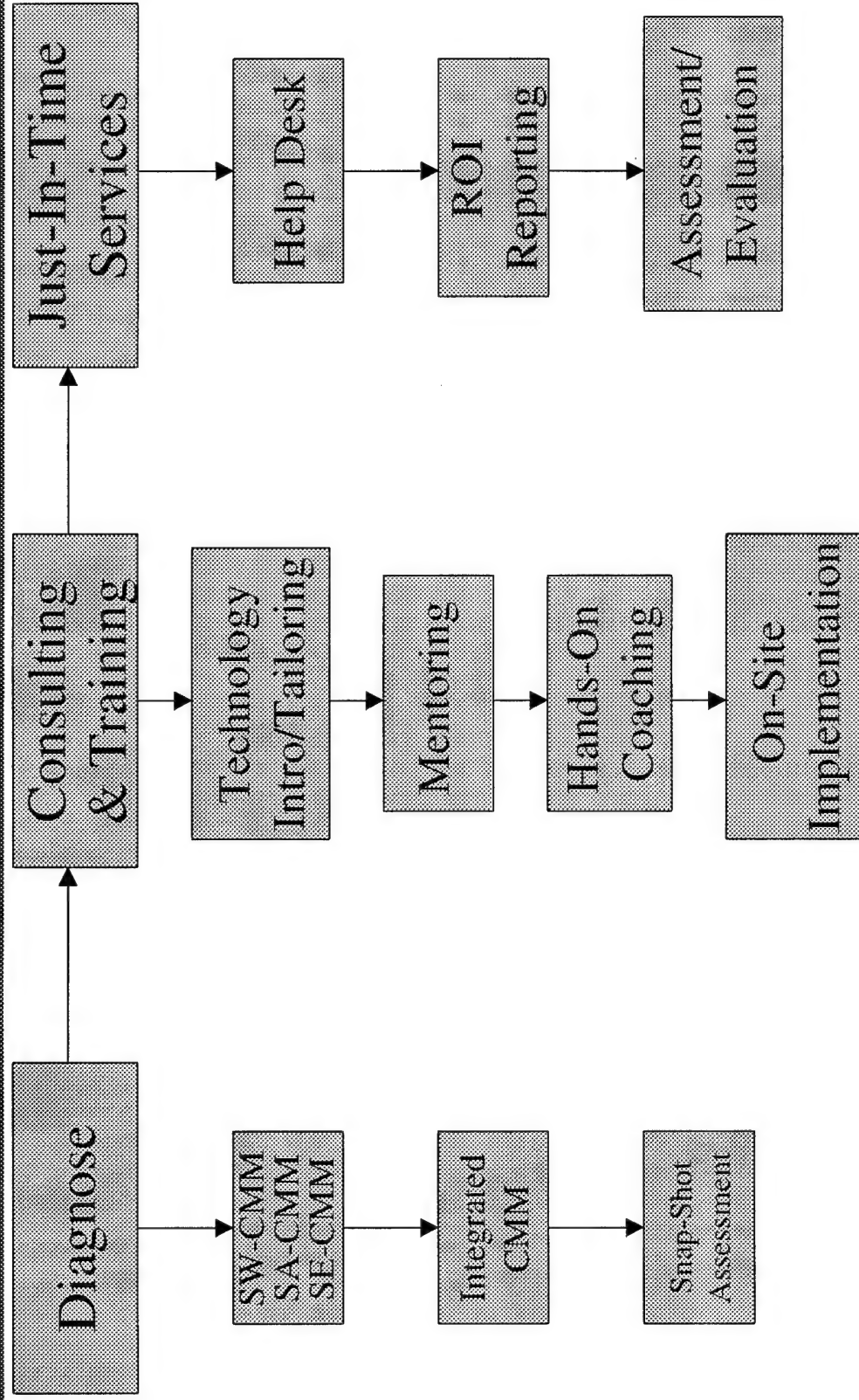
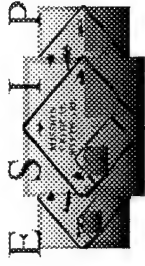
Technology Evaluation & Adoption Services



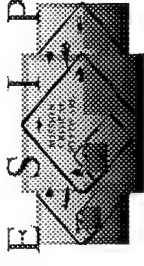
- ◆ Help software organizations
 - ⇒ exploit resources, measures/processes
 - ⇒ to regularly use effective technologies to improve software production quality, efficiency or predictability
- ◆ Provide organizational needs analysis, strategic planning, team development, technical workshops, hands on guidance, and implementation counsel & mentoring



Technology Adoption Services & SPI Support Functions



ESIP PMD Task 4: Software Readiness



Software Readiness Tasks

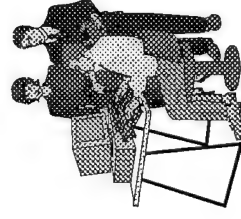
- Upgrade AF software stock, store & issue capabilities
- Disseminate software best practices
 - Provide updates to "Guidelines for Successful Acquisition & Management of Software Intensive Systems"
- Support software process improvement efforts
- Integrate measurement efforts



*Web-based
Enterprise*



*Technical
Guidance*

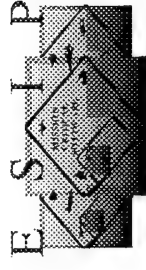


*Program
Support*



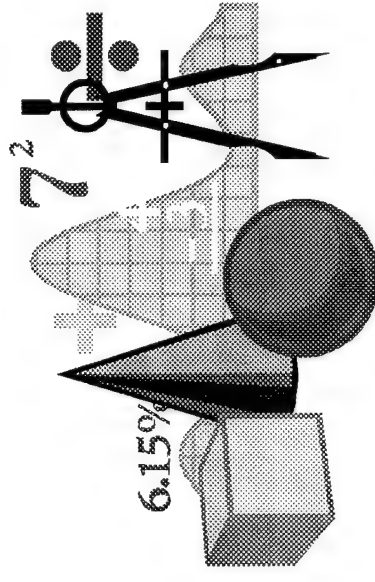
*Training
Courses*

Software Readiness

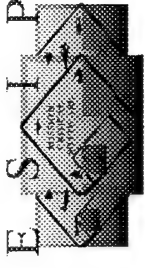


Support Software Process Improvement (SPI)

- ◆ Software Engineering Process Groups at AFMC Centers
- ◆ Corporate SPI Support Functions thru STSC
 - ⇒ Corporate SPI Guidance for AFMC SEPGs
 - ⇒ SPI Help Desk
 - ⇒ SPI Return on Investment (ROI) reporting
- ◆ Capability Assessments & Evaluations
- ◆ SPI Training & Consulting thru STSC
 - ⇒ Practical Software Measurement
 - ⇒ Software Acquisition, Sys Engineering, Project Mgt, & Estimation
 - ⇒ Capability Maturity Models (CMMs -- level 2-5 KPAs)
 - ⇒ Integration of CMM Training (with SEI) & Tailoring for pilot projects



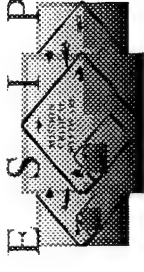
Software Readiness



Software Process Improvement (SPI) for Supported Programs

- ◆ SPI efforts quantifiably justify funding (based on several projects)
 - ↑ Demonstrated Return on Investment of 3:1 - 9:1
 - ↑ Earlier Detection of S/W Defects from 22% - 90%
 - ↑ Reduction in post-release defects from 39% - 84%
 - ↑ Reduction in schedule time from 19% - 23%
 - ↑ Reduction in projected schedule variance down to 2%
 - ↑ Increased Productivity (less rework) of 35% - 75%
 - ↑ Reduced Sustainment costs by 30% - 55%
- ◆ Several ESMP or STSC-supported programs have improved their capabilities based on the SEI Capability Maturity Models (CMMs); reporting improved customer satisfaction in software support

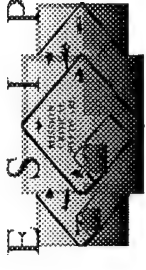
Process Improvement Business Case



CMM Integration Benefits

- ◆ Integrated CMM leverages experience with individual CMMs
 - ⇒ Use SEI, STSC & AF SEPG infrastructure in transitioning & tailoring
 - ◆ More easily obtain improvements in areas addressed in other CMMs
 - ◆ Demonstrates how CMMs complement each other
 - ◆ More consistent use of CMMs among disciplines
 - ⇒ Integrated CMM-based assessments (gap analysis) provide more complete understanding of enterprise-wide needs
 - ⇒ Supports institutionalization of enterprise-wide process improvement
 - ◆ Capability levels provide focus to apply the concept to a single process
 - ◆ Maturity levels provide roadmap for sequencing improvement activities
- ◆ Gets customers/users involved in process improvement
 - ⇒ Improves service to primary ESIP customers -- Sustainment Practitioners
 - ⇒ Promotes gains in user advocacy for process improvement

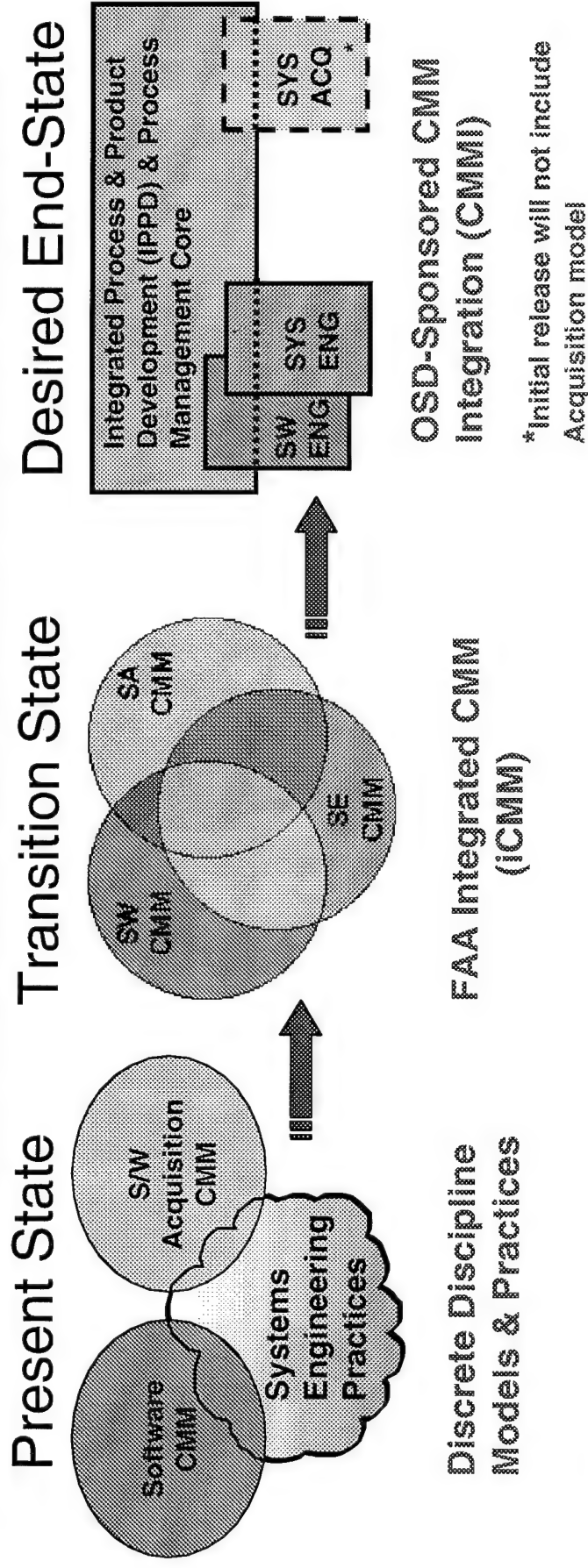
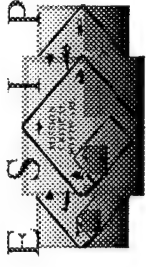
Enterprise-wide Process Improvement



ESIP Support Role

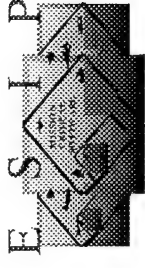
- ◆ Participation in OSD-sponsored CMM Integration (CMMI) PDT
- ◆ Enterprise-wide process improvement for specified programs
 - ⇒ Provide training & tailoring of integrated CMM with support tools
 - ◆ Provide training for FAA integrated Capability Maturity Model
 - ◆ Provide supplemental training in individual CMM process areas
 - ◆ Provide training in use of Aimware tool suite
 - ◆ Facilitate loading of tool with models and Center's processes
 - ⇒ Support assessment for gap analysis to determine specific needs
 - ⇒ Provide Train-the-Trainer training in Practical Software Measurement methodology & PSM Insight tool
 - ⇒ Provide follow-on mentoring & hands-on support, as needed
- ◆ Support collection of ROI data, lessons-learned and project & enterprise-wide measurements

An Evolutionary Change Approach



- ♦ Models used to guide enterprise-wide process improvement
 - ⇒ *Several users have requested Acquisition model to be included
 - ⇒ “IPPD is management technique that integrates system acquisition function using inter-disciplinary teams to optimize the process”
- ♦ Automated analysis relative to different models to provide gap analysis
 - ⇒ To focus process-specific improvements based on business objectives
 - ⇒ To guide training and resource allocation

Software Readiness



Integrate Measurement Efforts

using

Practical Software Measurement (PSM) ***as the foundation for objective project management***

Joint Logistics Commanders (JLC)

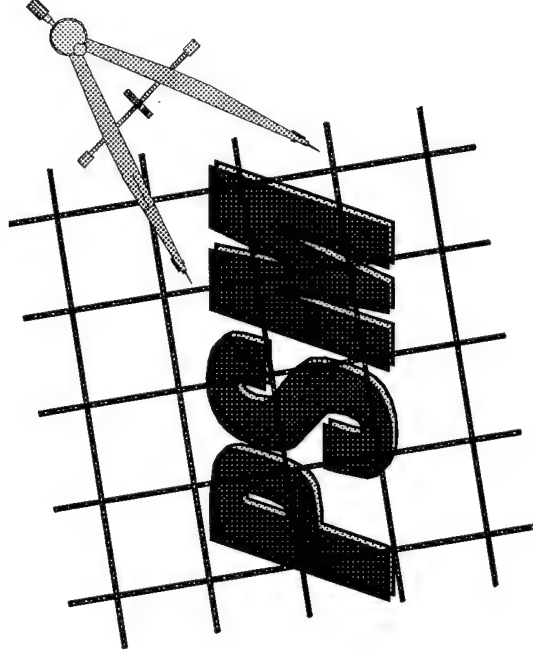
Joint Group on Systems Engineering (JGSE)

Office of the Under Secretary of Defense

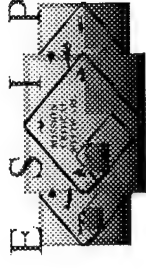
Acquisition and Technology -- OUSD (A&T)

ESIP / STSC provide key USAF participation:

- USAF PSM Development & Transition Partner*
- AFMC Metrics Working Group Chair*
- AF Rep on OSD's SEI Software Engineering Measurement & Analysis (SEMA) IPT*



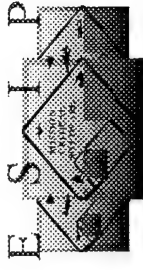
Why Measurement is Important



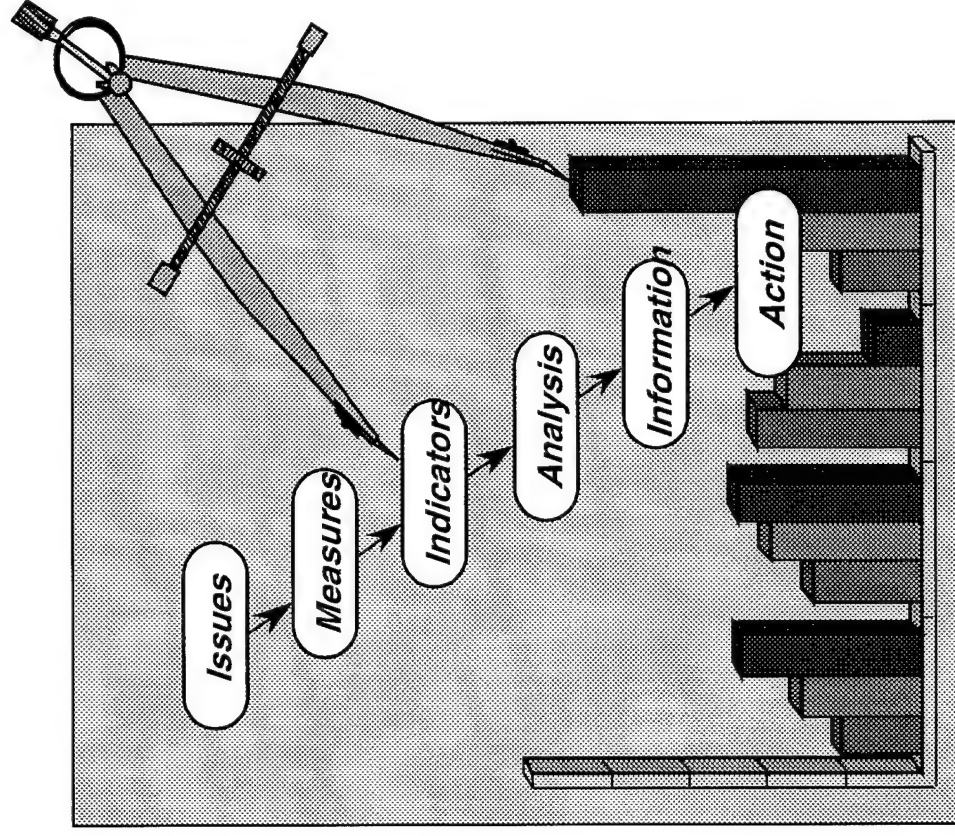
Today's DoD Project Environment

- ◆ Acquisition Reform & Outsourcing
 - ⇒ More complex risk management responsibilities
 - ⇒ Diminishing organic resources
 - ⇒ Reliance on commercial products and processes
 - ⇒ Integrated program management
- ◆ IT Performance Measurement
 - ⇒ Results-based mission improvement
 - ⇒ Enterprise-wide process improvement emphasis
 - Performance based acquisition & sustainment
 - Process improvement emphasis

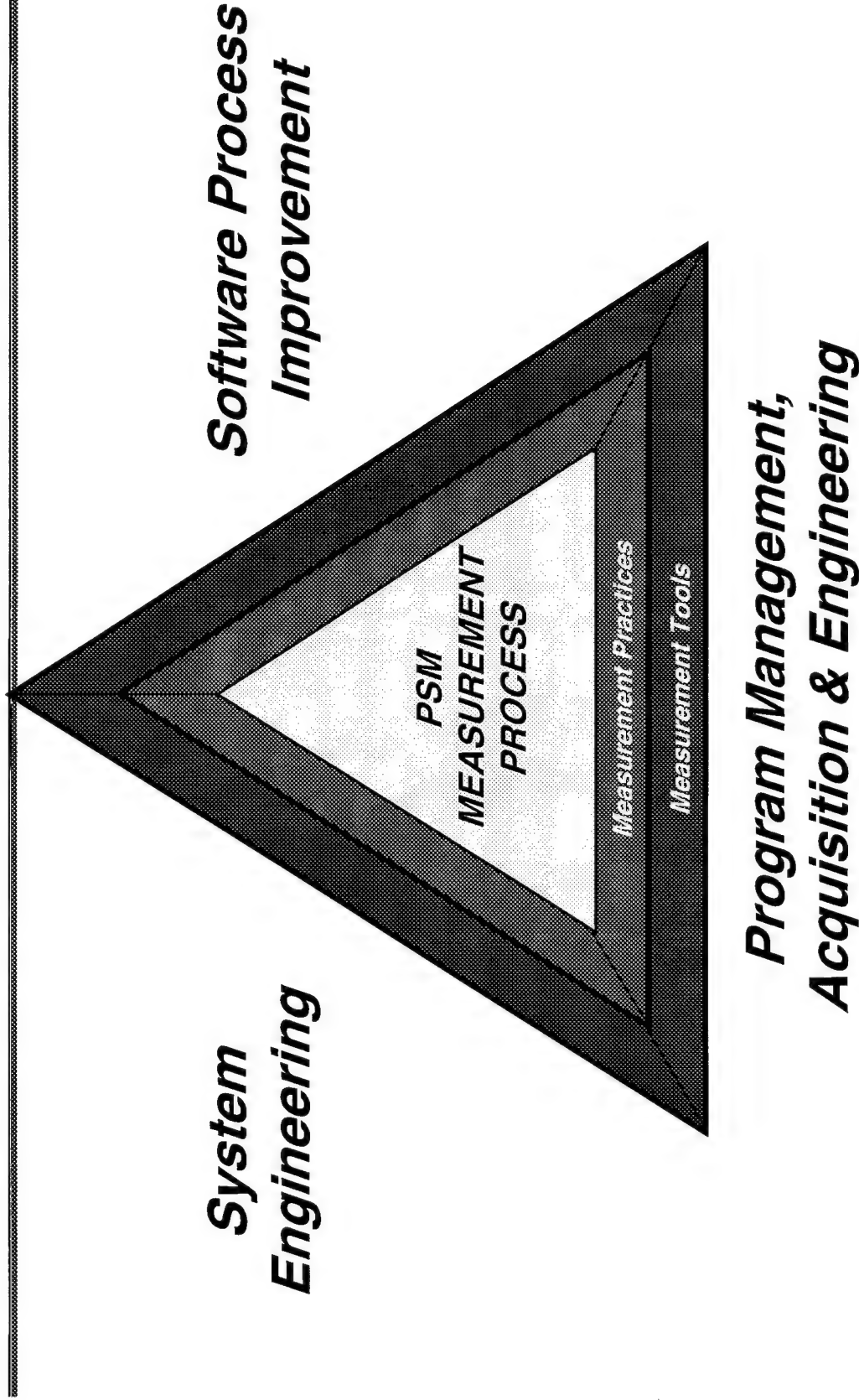
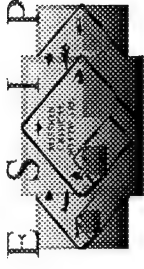
Why Measurement is Important



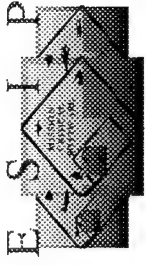
Measure Everything That Results in Customer Satisfaction



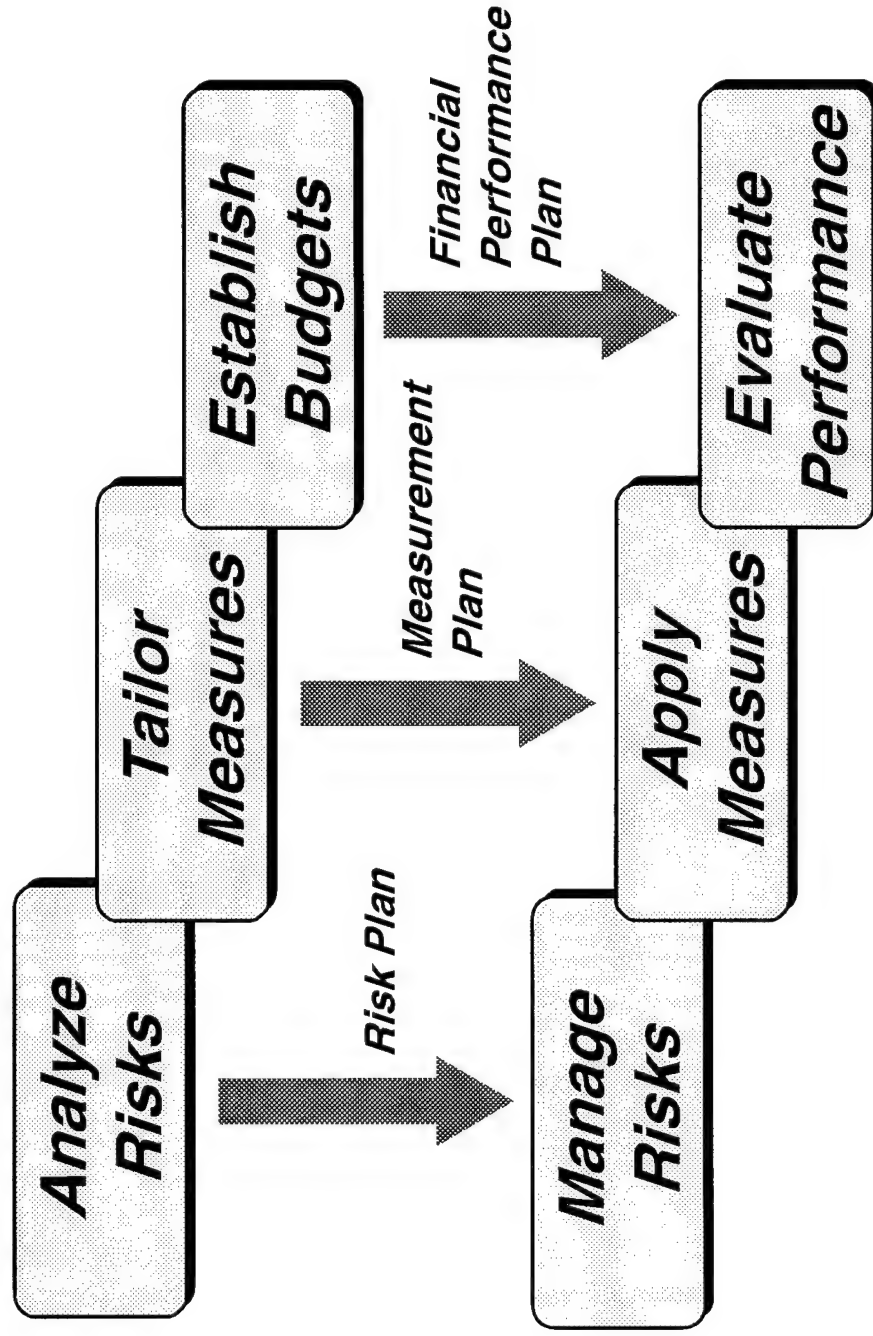
Integrating Qualitative Management



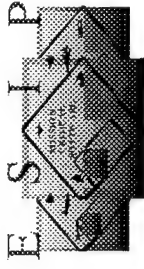
PSM Links Management Functions



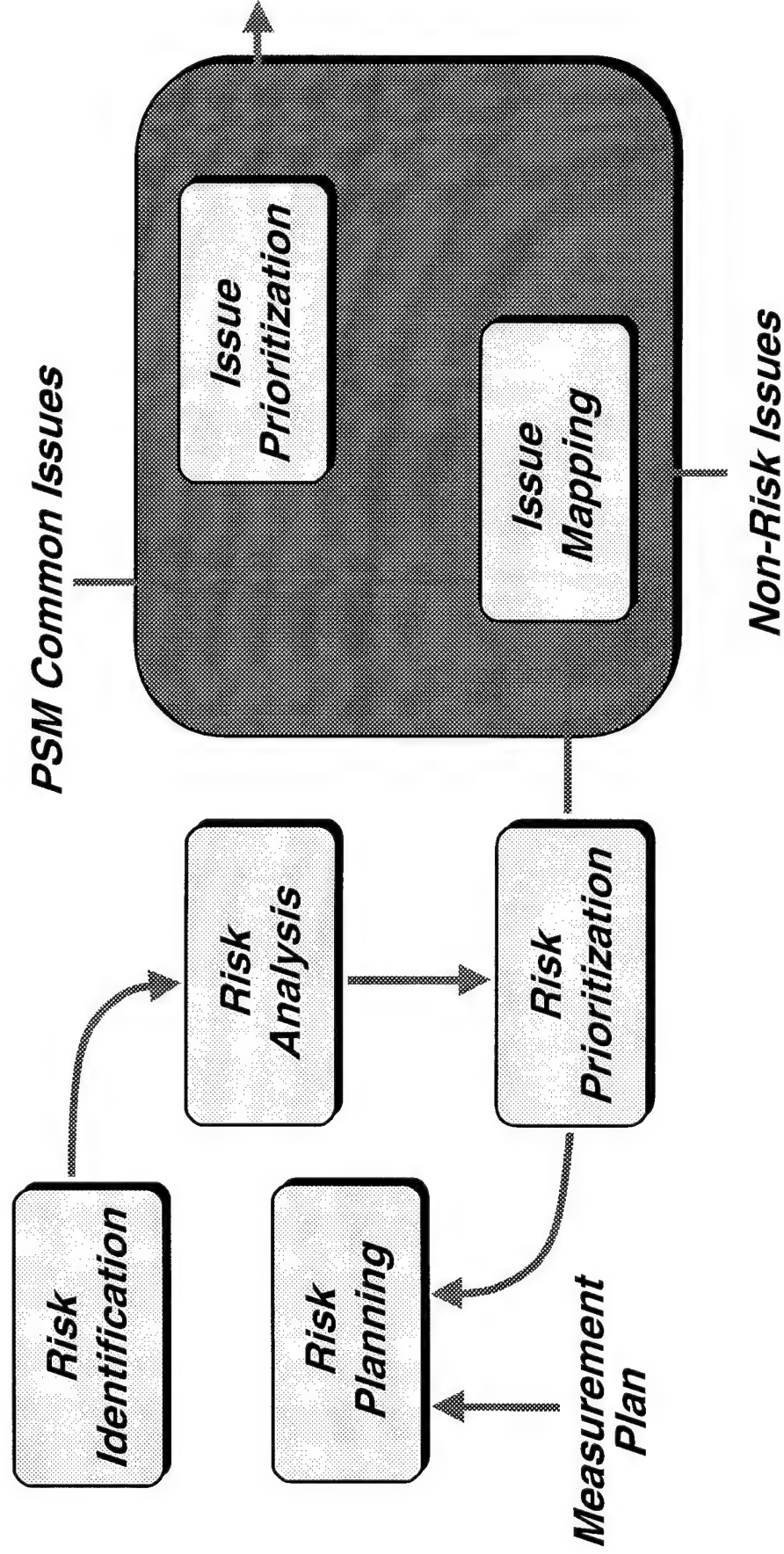
Quantitative Management



Identify and Prioritize Project Issues

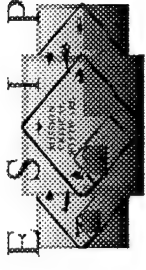


Risk Management relationship to PSM

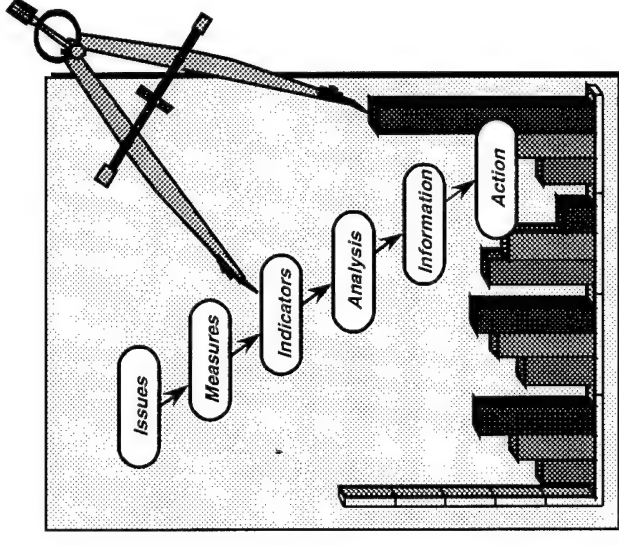


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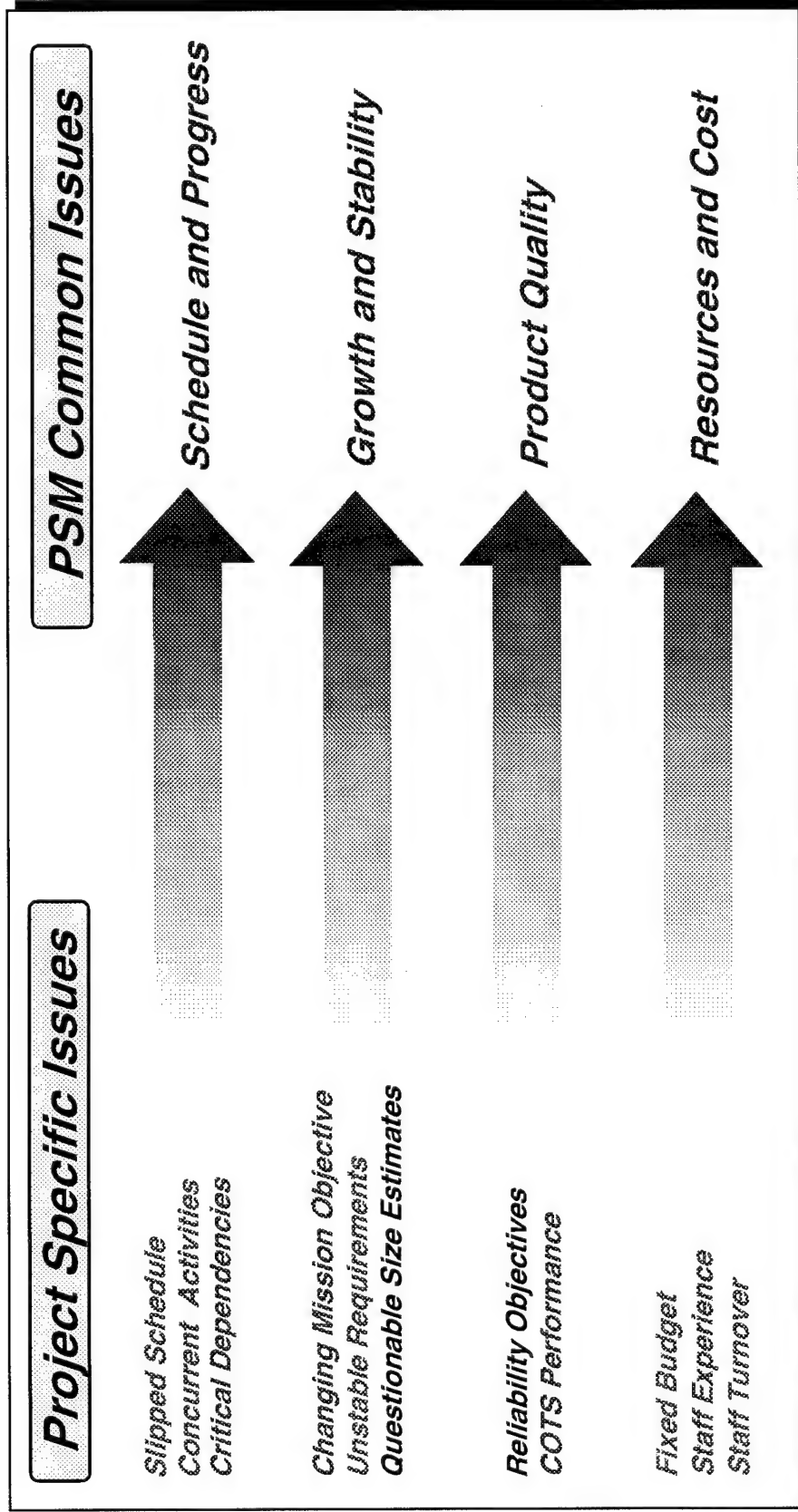
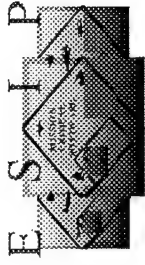
What Program Managers Need to Know



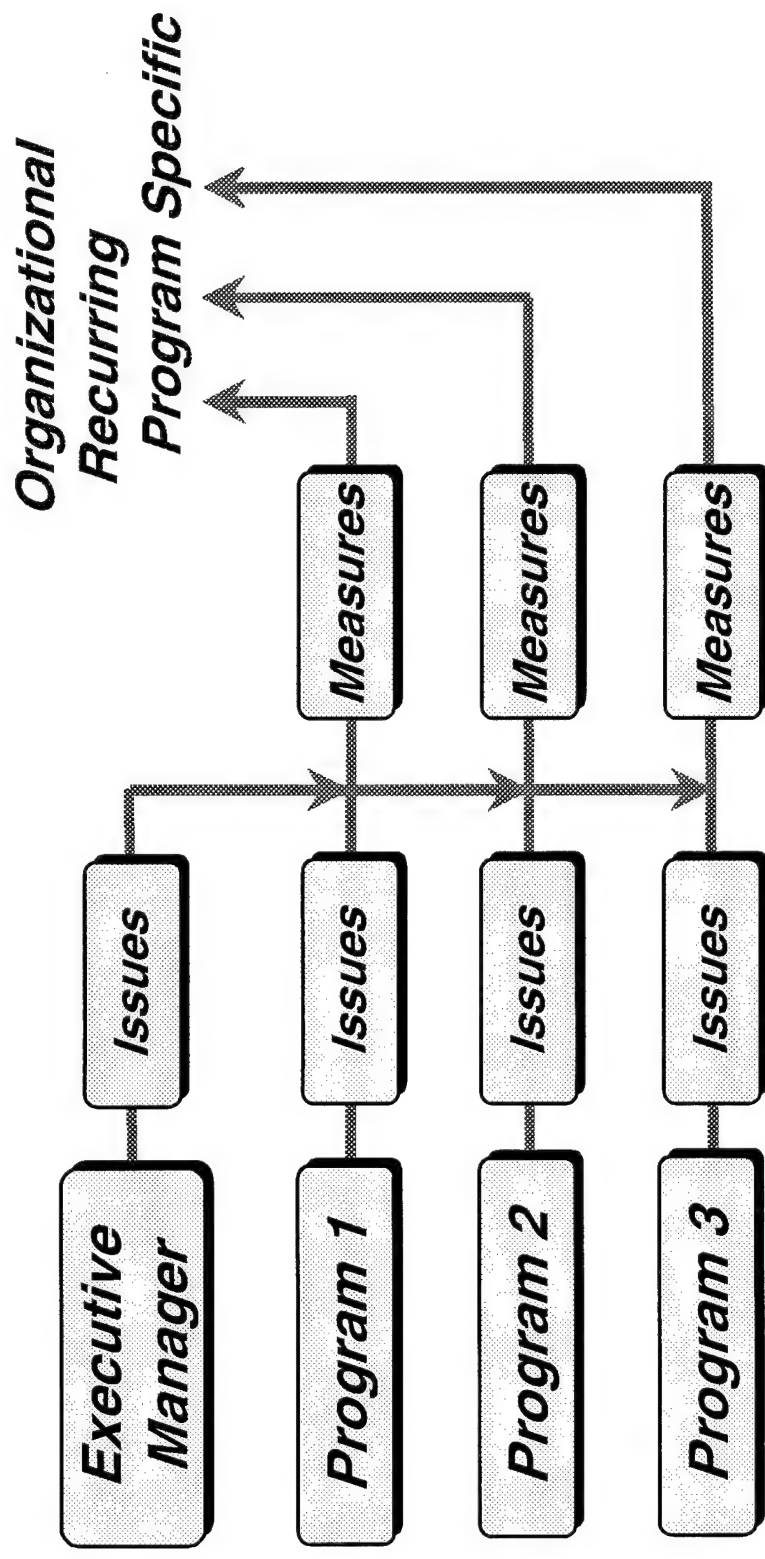
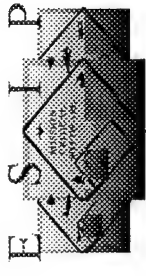
- Is there really a problem?
- How big is the problem?
- What is the scope of the problem?
- What is causing the problems?
- Are there related problems?
- Can I trust the data?
- What should I expect; what will happen?
- What are my alternatives?
- What is the recommended course of action?
- When can I expect to see results?



Issue Mapping

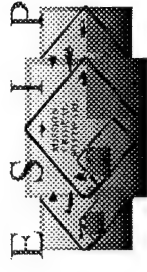


Measurement Across Multi-Programs



- There Are Multiple Sources of Issues -They Must Be Prioritized Together
- Focus Initially On Project Level Measurement
- Standard Organizational Measures Require Consistent Issues & Processes

Updated PSM Product Set



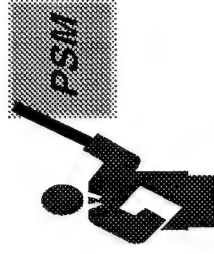
Updated Technical Guidance Version 3 *"Insight" Automated Measurement Tool* *Revised Training Courses* *Program Support*



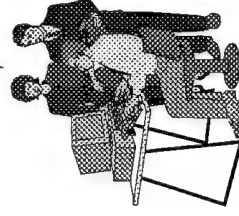
**Technical
Guidance**



**Measurement
Workstation**



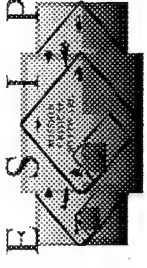
**Training
Courses**



**Program
Support**

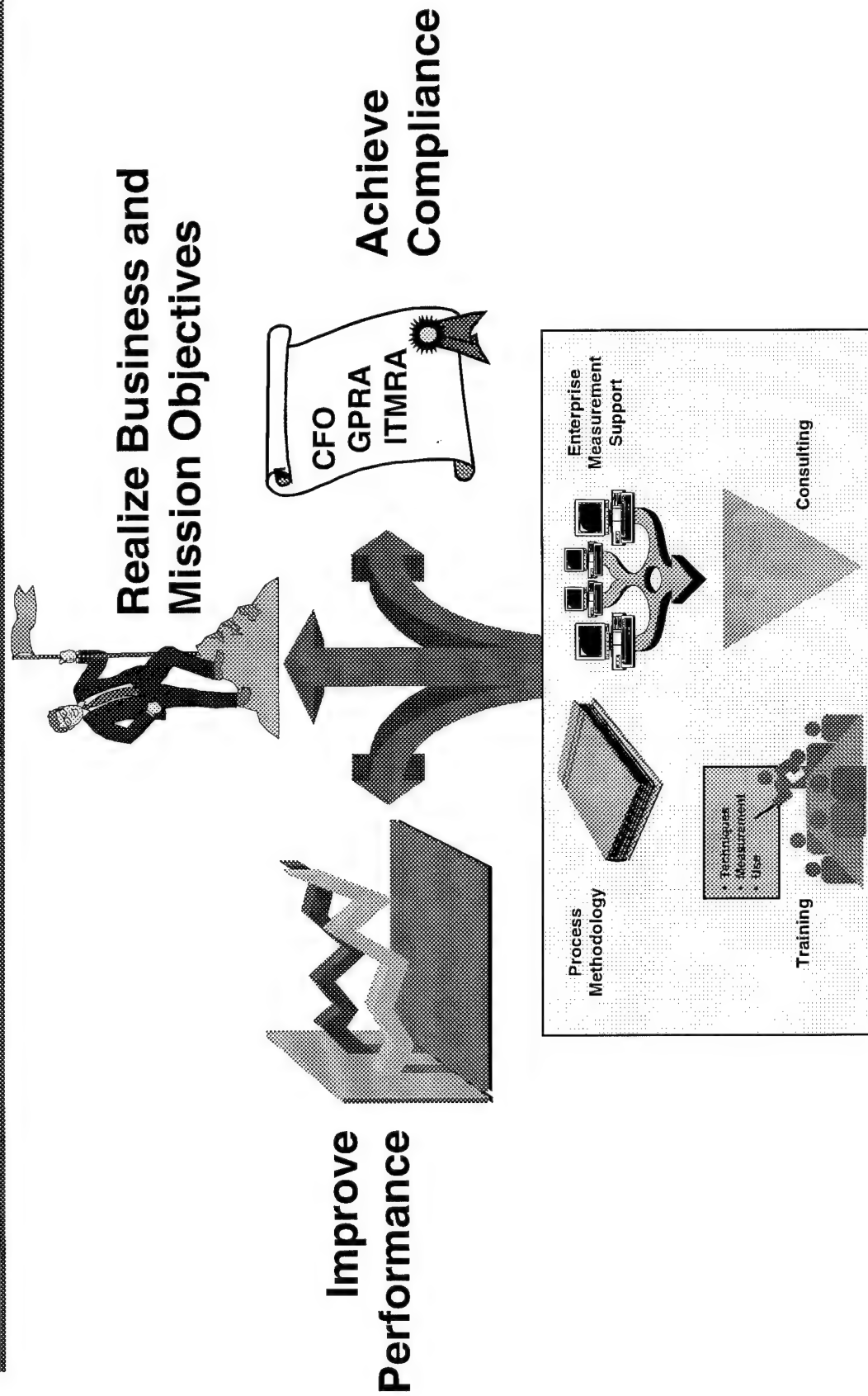
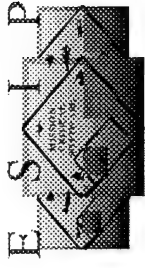
*'Insight' tool automates PSM Process;
Provides Context & Quantitative Data and
Tailorable Database Design, Graphs & Reports*

PSM Now in Use

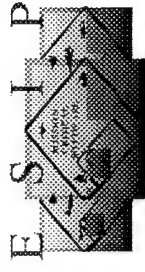


- ◆ ***PSM defines and helps to implement an effective measurement process***
 - ⇧ ***Provides foundation for quantitative project management and basis for effective decision making at all levels***
 - ⇧ ***Supports DoD SW Acquisition & Measurement Policy; provides basis for integrating all DoD-related measurement resources & efforts, including SEI SW Eng Measurement & Analysis***
- ◆ ***PSM Guidance***
 - ⇧ ***Developed by measurement professionals from DoD, other Government agencies, and Industry***
 - ⇧ ***Producing measurement guidance and related products, and is transitioning measurement into practice***
- ◆ ***PSM Users' Conference 19-23 July in Breckenridge, CO (see web site at www.psm-sc.org)***

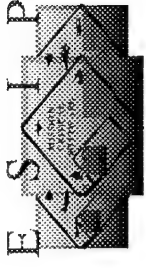
Customer Benefits



Summary

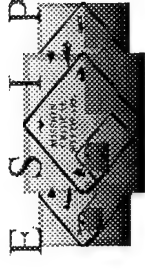


- Industry & DoD face business challenges associated with software
- ESIP is an cross-cutting program addressing software issues
 - Proven Return on Investment & cost avoidance
 - Accommodates diminishing resources through strategic alliances that leverage the efforts of other programs
- ESIP offers Lessons Learned & opportunities for participation
 - AF R&D in conjunction with Commercial Independent R&D
 - Software Technology Support
 - Technology Information Services
 - Technology Evaluation & Adoption Services
 - Software Readiness
 - Disseminate Software Best Practices
 - Provide corporate support for software process improvement
 - Transition performance measurement technologies to help programs attain business and mission objectives



Additional Questions & Comments

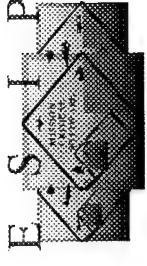
Role of Capability Maturity Models - Facilitate Improvement Efforts



Use of Capability Maturity Models (CMMs)

- › A CMM provides a foundation for progressive process improvement
 - › As a model of industry best practices, serves as standard for evaluating current capabilities and identifying areas that should be improved
 - › Provides a structured framework to support the prioritization of actions in a phased approach for improvement
 - » Defines the expectation (the “what”) without overly constraining the implementation (the “how”)
- › Provides roadmap and building blocks for incremental improvement associated with organizational process maturity
- › CMM-based improvement can be achieved in tandem with other improvement efforts, e.g., TQM, ISO 9000 Series

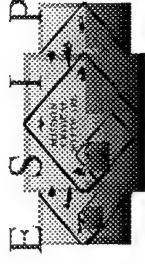
Role of CMMs - Facilitate Improvement Efforts



Conceptual Understanding of the Use of Integrated CMMs

- ◆ **Integrated CMM supports staged & continuous architecture**
 - ⇒ **Staging (grouping of key process areas into maturity levels)**
 - ◆ facilitates a summarization of organizational maturity level based on experience with successful process improvement priorities
 - ◆ avails guidance regarding priority & ordering of processes
 - ⇒ **Continuous architecture separates process areas**
 - ◆ facilitates addition of new process areas into the model,
 - ◆ guides improvement of any selected process area to any desired level,
 - ◆ affords detailed measurability at the process level,
 - ◆ leaves it to the organization to decide priority & ordering of processes to improve based on business objectives
 - ◆ facilitates, through staging, a summarization of organizational maturity

Process Improvement Business Case

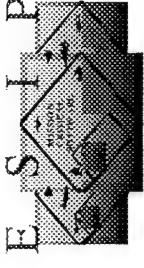


Why Focus on Process Improvement?

- › Establish a common understanding of the customer's requirements between the customer and the project team
- › Establish reasonable plans for performing systems and software engineering and for managing projects
- › Provide adequate visibility into the actual progress so management can take effective actions when the project's performance deviates significantly from plans
- › Ensure the integrity of the project's products are established and maintained throughout the project's life cycle; **remove defects early and efficiently** from work products
- › **Select and manage qualified subcontractors**

ESIP

Process Improvement Business Case



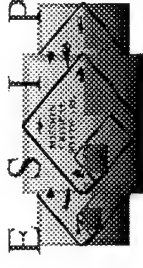
Value of Enterprise-wide Process Improvement

› Establish organizational inter-departmental process improvement

- › Develop and maintain a usable set of process assets that improve process performance across the projects being developed & sustained
- › Ensure software engineering group actively participates with other engineering groups to satisfy customers' needs effectively and efficiently
- › Integrate all software engineering & systems engineering activities to produce correct, consistent products effectively & efficiently
- › Integrate engineering and management activities into a defined process that is tailored from the organization's standard process and related process assets for each project

› Develop common language, skills & knowledge of the individuals so they can perform their roles effectively and efficiently

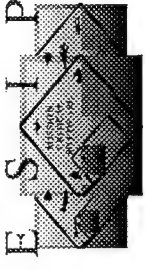
Process Improvement Business Case



Use of Capability Maturity Models (CMMs)

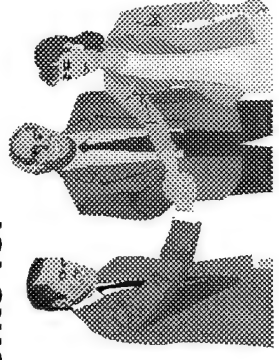
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Process Improvement Business Case



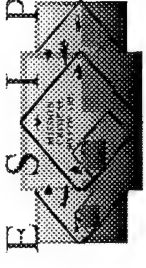
Benefits of Continuous Process Improvement

- › **Improved understanding of how the organization develops and delivers software-intensive systems**
- › **Increased control of costs, schedule & product quality**
 - › Reduced development cycle time by reducing rework
 - › Reduced schedule variance
 - › Increased predictability and control of software and product quality
 - › Enhanced risk management decisions based on quantitative data
- › **Improved environment for management and workforce**
 - › Ability to make cost-benefit tradeoffs of applicable technologies/processes
 - › More time available to spend on problems requiring creative energy
 - › People feel more empowered to propose process improvements for organization-wide benefit
- › **More competitive organization**
- › **Satisfied customers**



590

Process Improvement Business Case

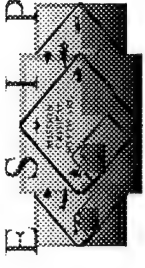


Characteristics of A Mature Process

- › Defined and documented
- › Clear definition and understanding of roles and responsibilities throughout project and organization
- › Supported visibly by management
- › Used and is consistent with the way work actually gets done
- › Well controlled - fidelity is audited and enforced
- › Measured
- › Supported by technology when appropriate
- › Living & evolving (continuous improvement)



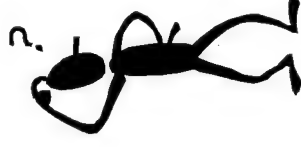
Process Improvement Business Case



Supporting Business Objectives

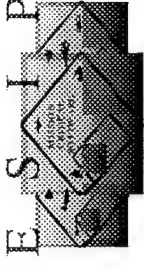
For a process improvement initiative to be successful, it must be tied to the organization's business objectives

- › What are the organization's highest priorities?
- › What business consequences have resulted from weak or ineffective processes?
- › What action is being taken to correct the cause?
- › How is the process improvement initiative seen to:
 - › support the organization's business objectives?
 - › tie into the organization's overall focus on quality management?



2008

Process Improvement Business Case



Business Objectives - Examples

- › Reduce delivery time and schedule variance
- › Enable effective communication between separate business units
- › Reduce system errors that are discovered by customers
- › Provide demonstrated Return on Investment
- › Increase quality of products
- › Increase productivity
- › Increase customer satisfaction



SPAWAR



SPAWAR



Ordnance on Target - With the Speed of Command

Captain Rich Zajicek, USN
Deputy Program Executive Officer
Space, Communications &
Sensors

17 June 1998



Our Mission

SPAWAR is the Navy Acquisition Command responsible for systems which move information to the Warrior

- Providing products
 - Physical systems/equipment
 - Architecture, standards, systems integration plans, concepts of operations
- Integrating all information products, including those developed by other systems commands and agencies outside the Navy

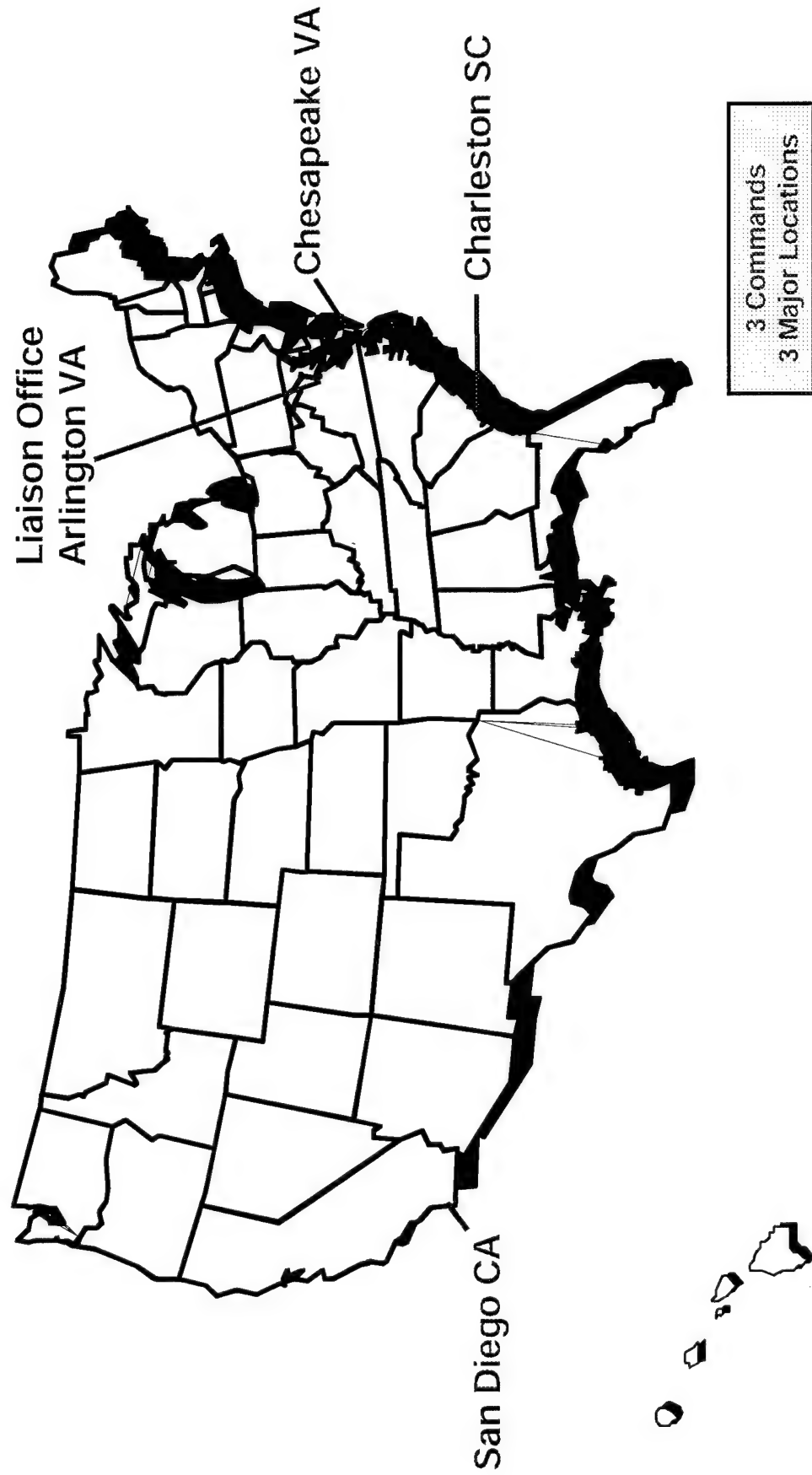


Our Mission

- To provide naval commanders a decisive warfare advantage through the development, acquisition, and life cycle management of effective and responsive:
 - Battle Management Systems
 - Software Applications, Computers, Displays
 - Undersea, Terrestrial and Space Sensors
 - Satellites, Underwater Sensor Arrays, Navigation and Weather Systems
 - Information Transfer Systems
 - Communications Systems, Radios, Satellite Ground Stations, Antennas, Switches
 - Information Management Systems
 - Infrastructure (LAN's, Routers, Hubs), Non-Tactical Software

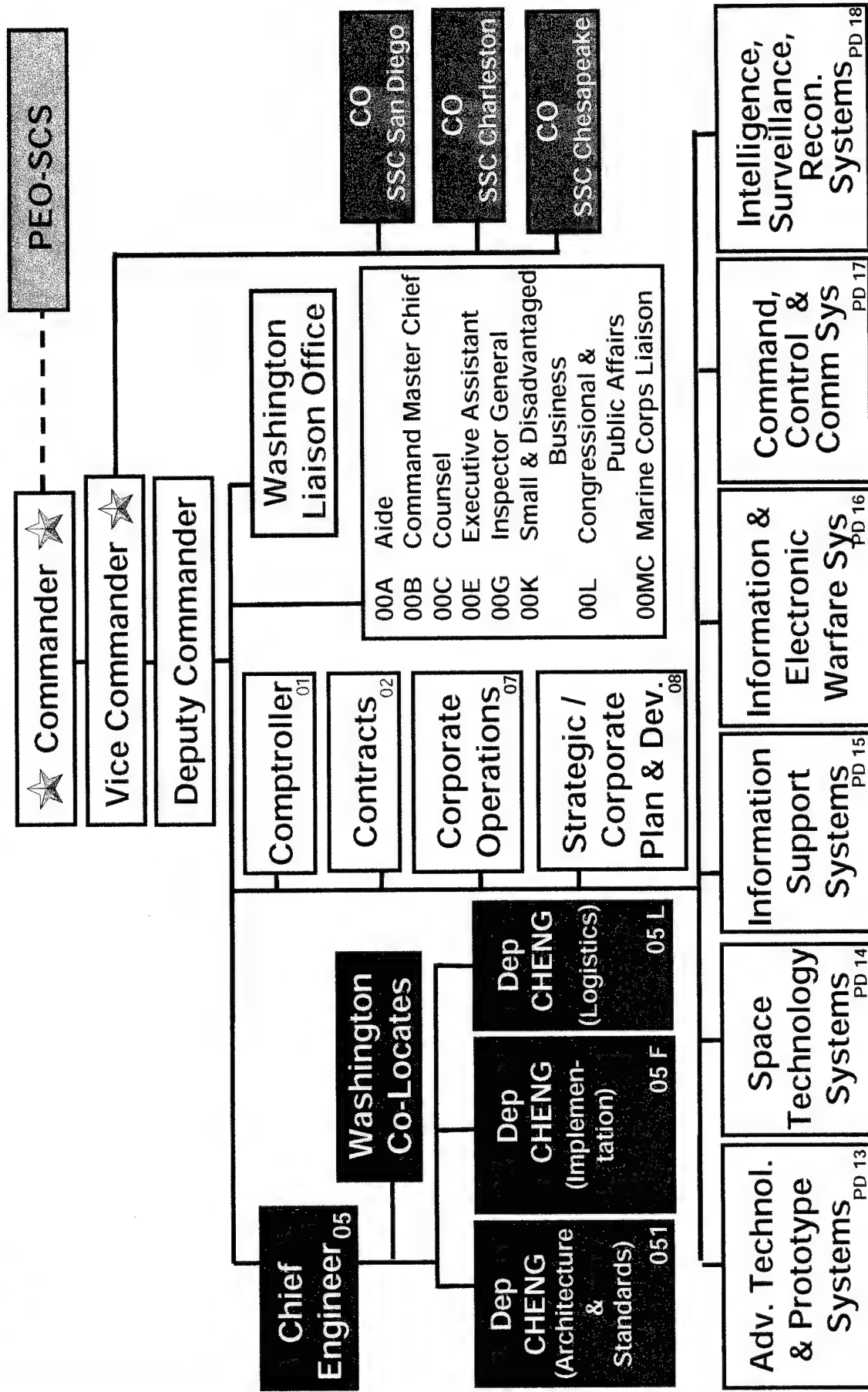


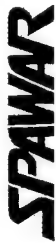
Corporate SPAWAR



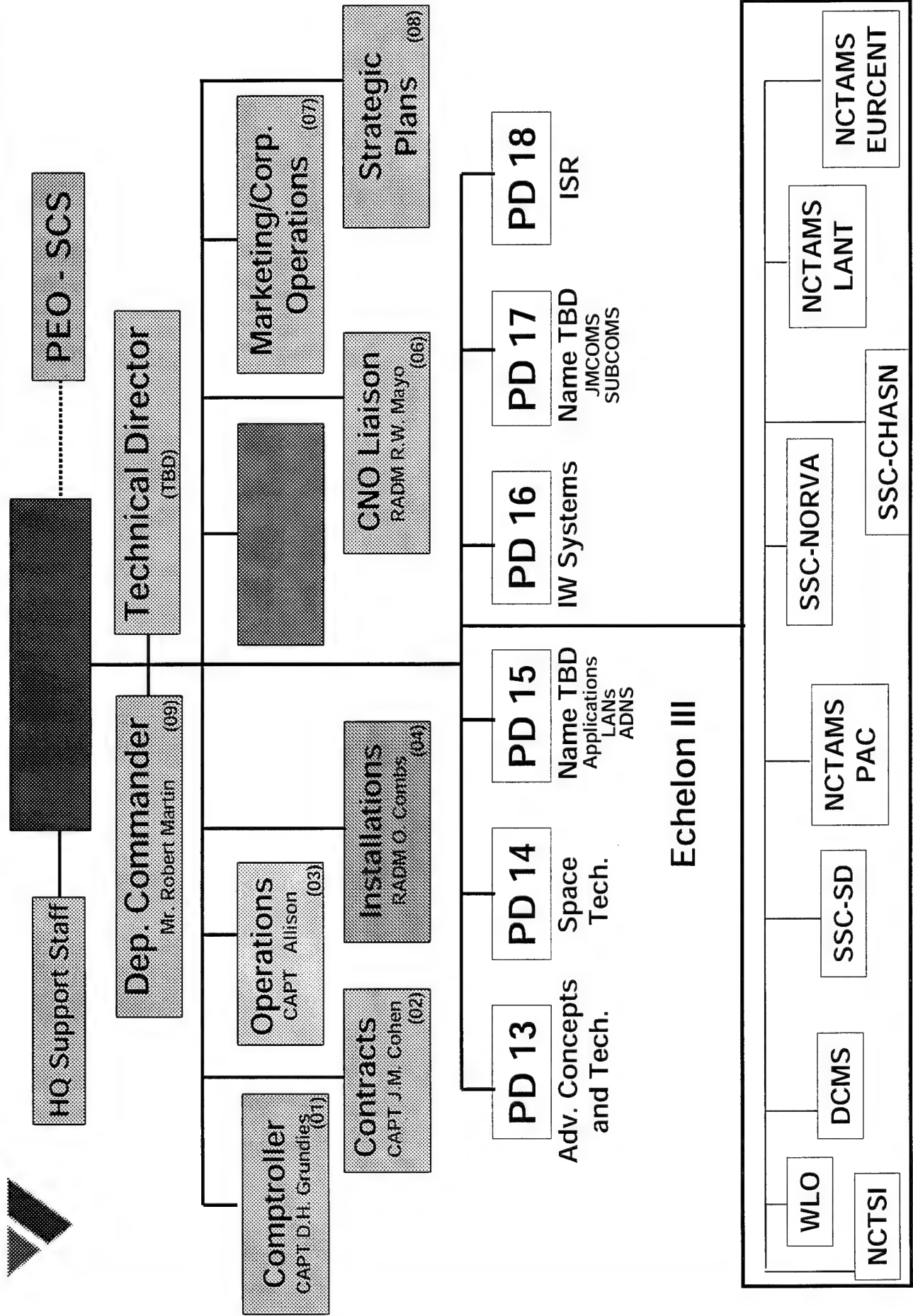


Space and Naval Warfare Systems Command





Echelon II Headquarters

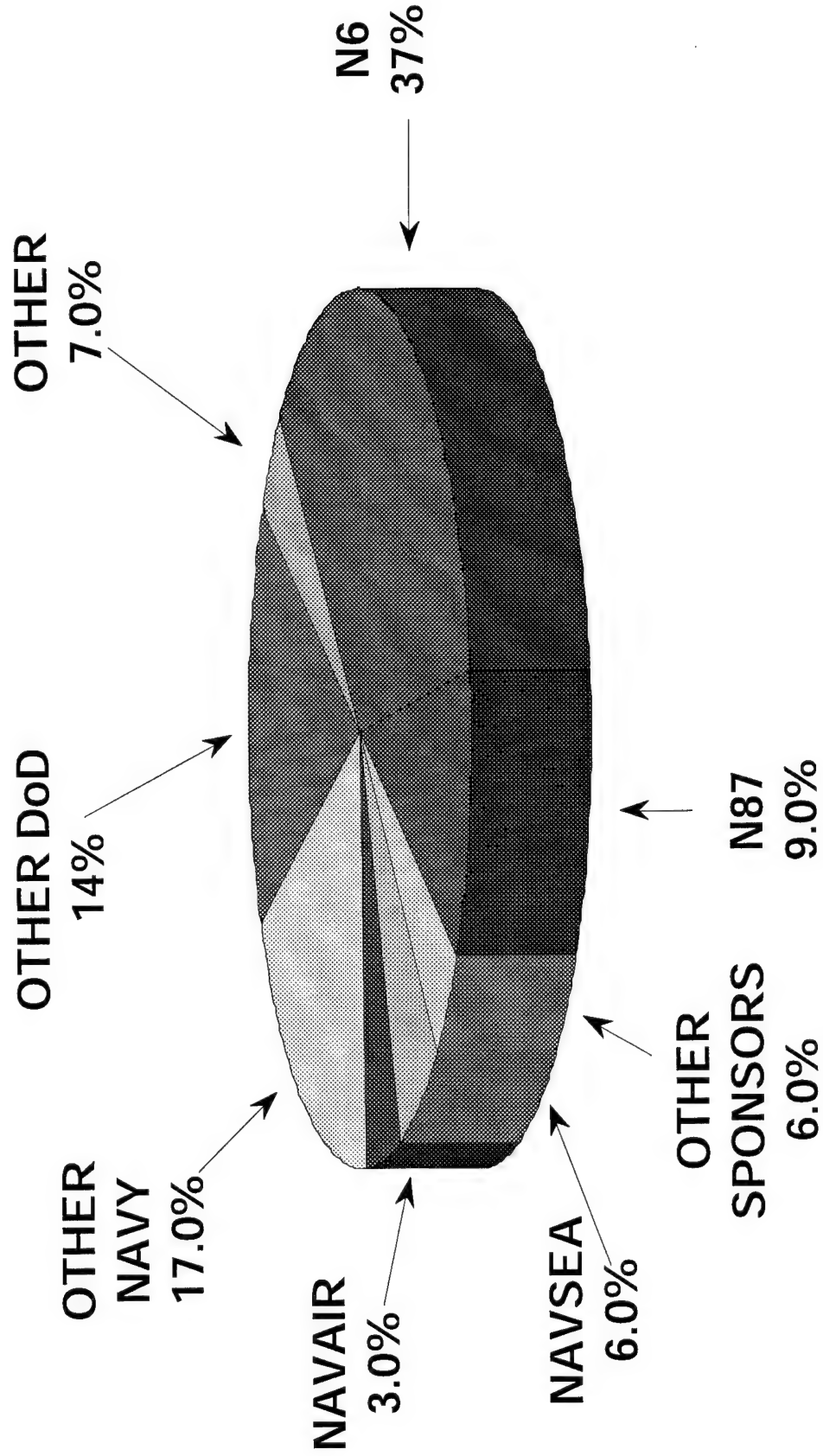


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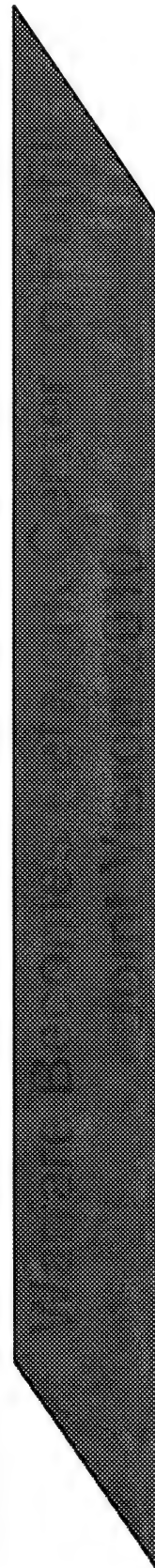
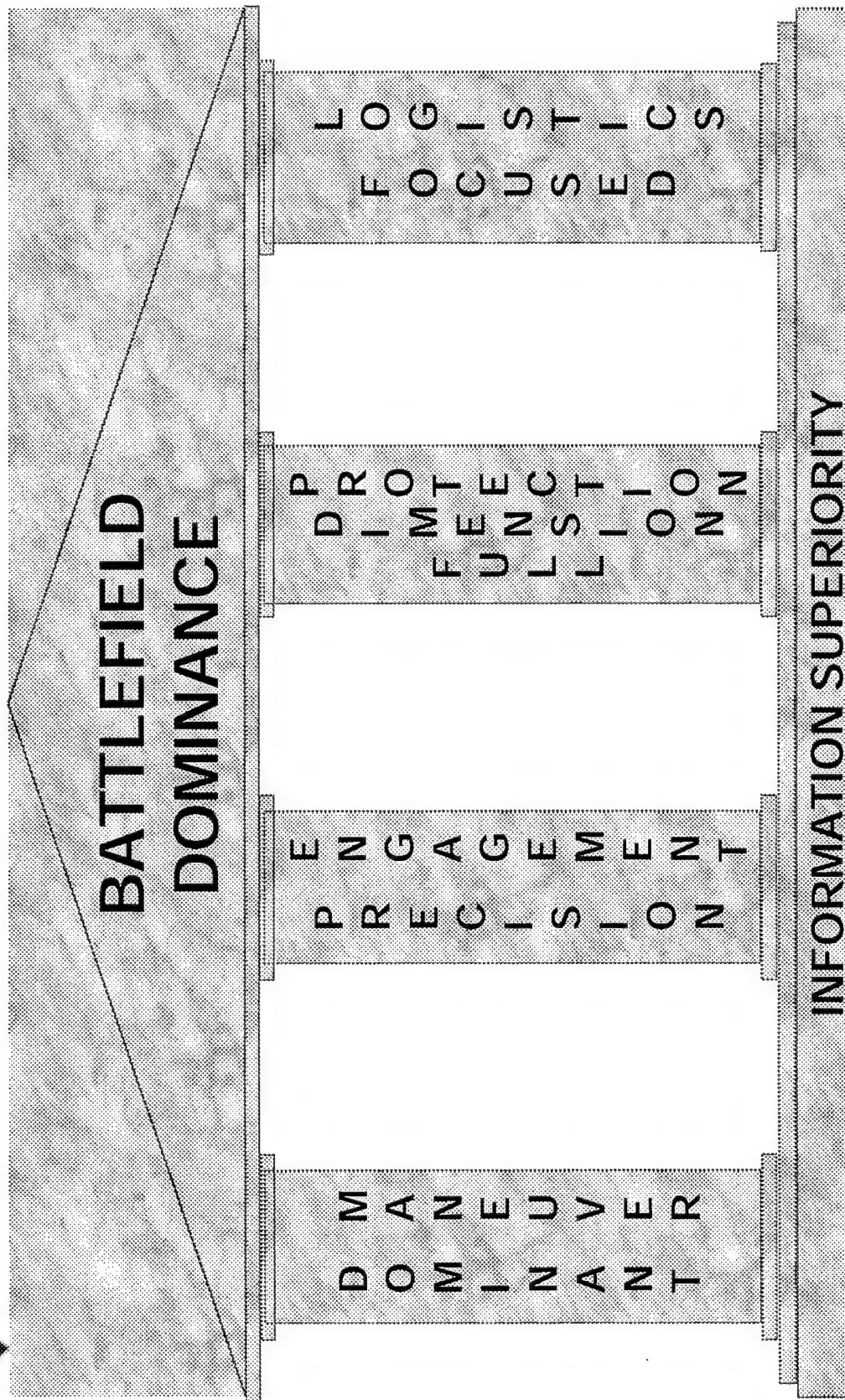
Our Sponsors

Total Corporate - \$3.549B
(Includes SSC-SD, PEO & Other Customer Funds)

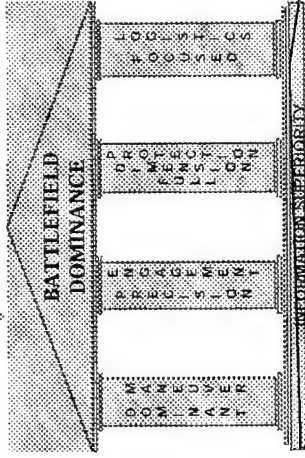




Joint Vision 2010



SPAWAR IT-21 is Part of the Solution



- "Ordnance on Target" with "Speed of Command" requires a strategy to do this

Integrate Tactical Data Links to common backbone & Interface Weapons Control to common backbone
Integrate C4ISR Applications & Data
Integrate Combat Support Applications & Data

Not
Included
in IT21

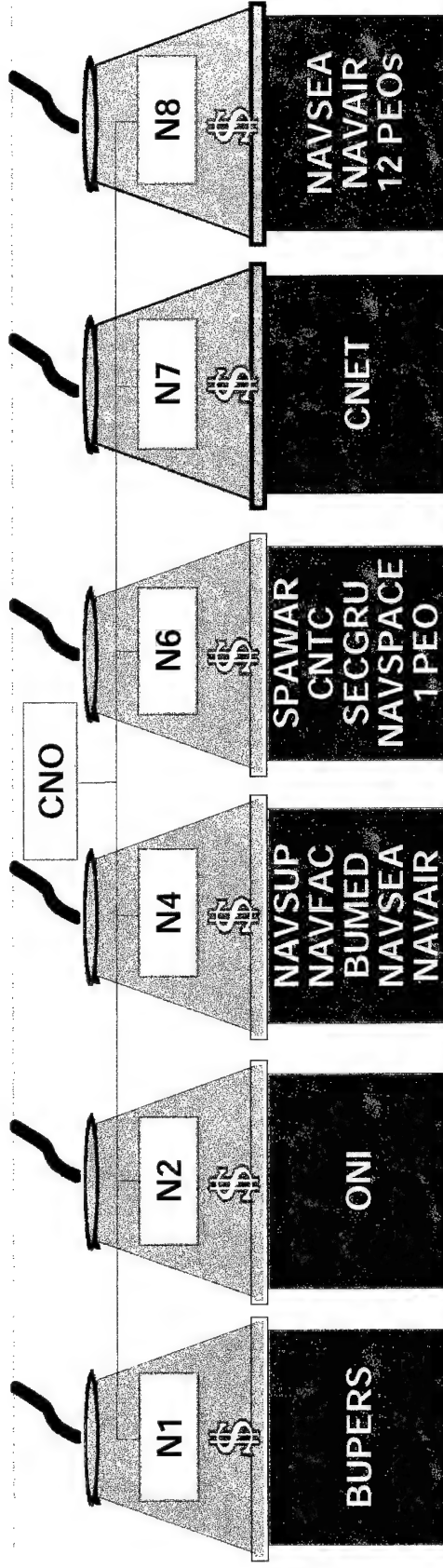
Infrastructure Foundation:
SATCOM / MANs / LANs / PCs /
ATM Backbone / Information Assurance

IT21

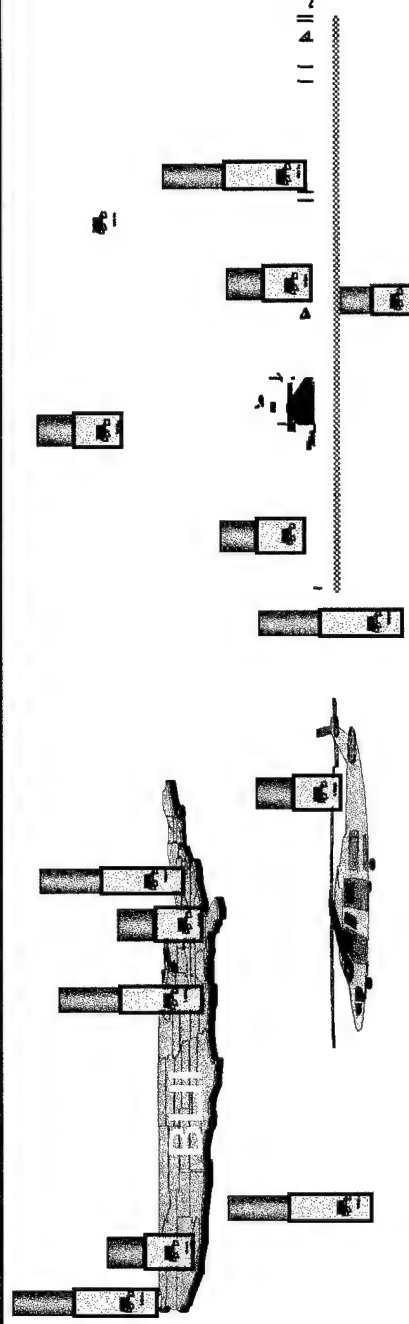
SPAWAR



Today's Paradigm: The Money Flow & The Results



"SYSCOMS" Follow OPNAV's Organization & The Money



The Result ... Stovepipes EVERYWHERE!!!

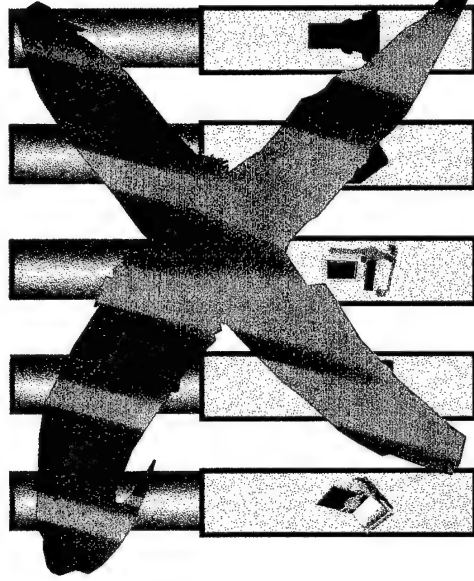
SPAWAR



To Achieve Joint Vision 2010 We Must Change the Paradigm

From:

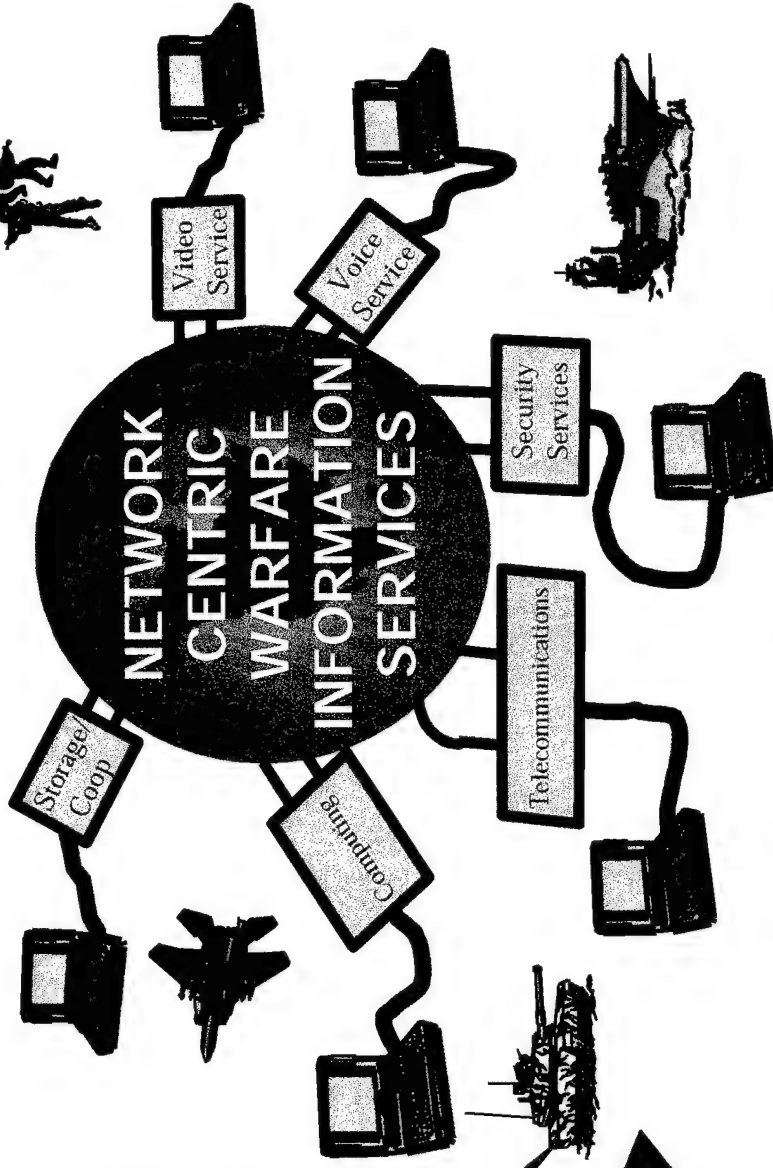
**Providing *Interfaced*
Stovepipe Systems**



C4I

To:

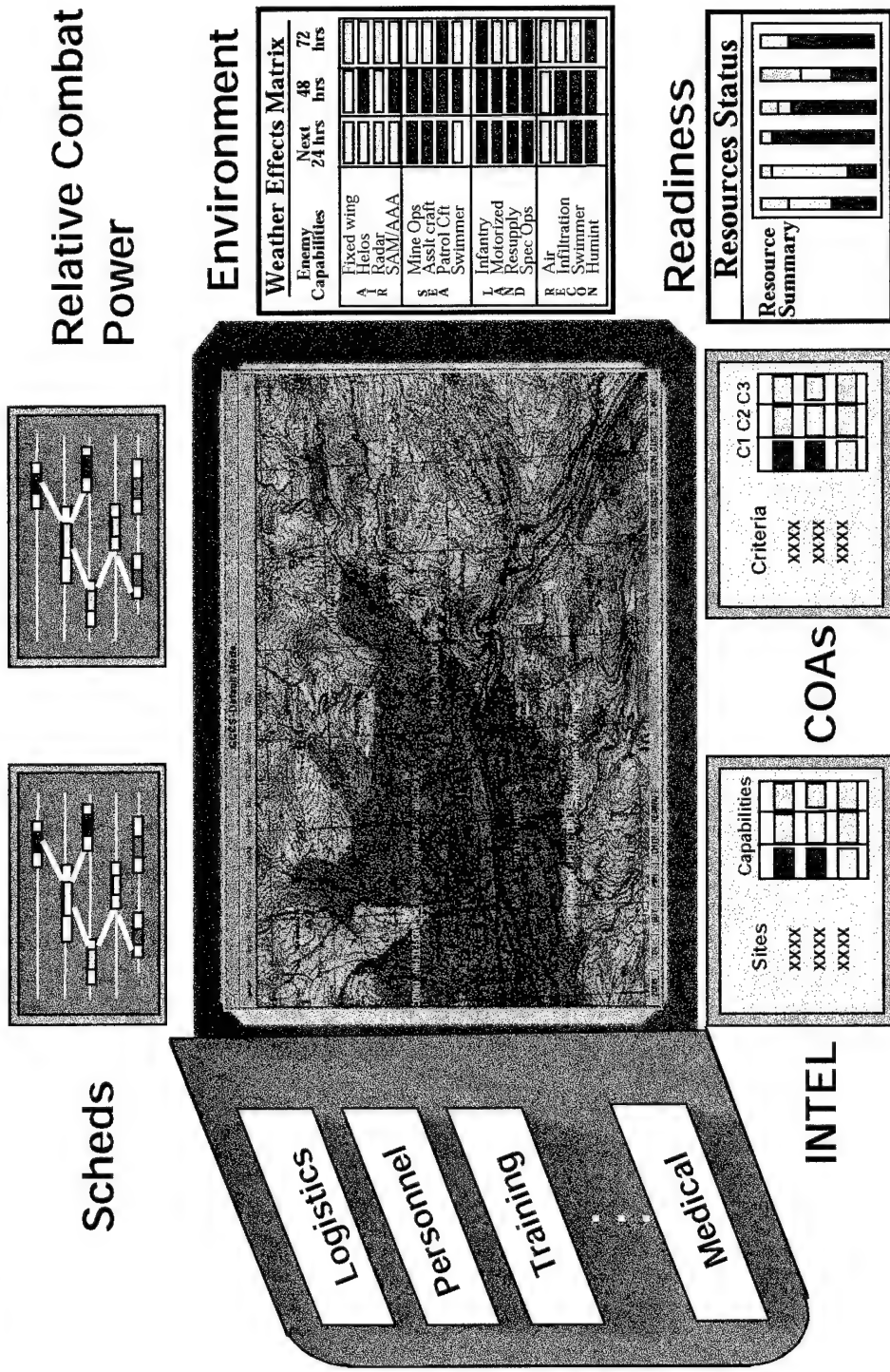
**Providing *Integrated* Information
*Functions & Services***



Anywhere, Anytime, Any Mission

SPAWAR The "Backplane" Enables Solving The Real Integration Problem:

Access to Integrated Information from a Single Window



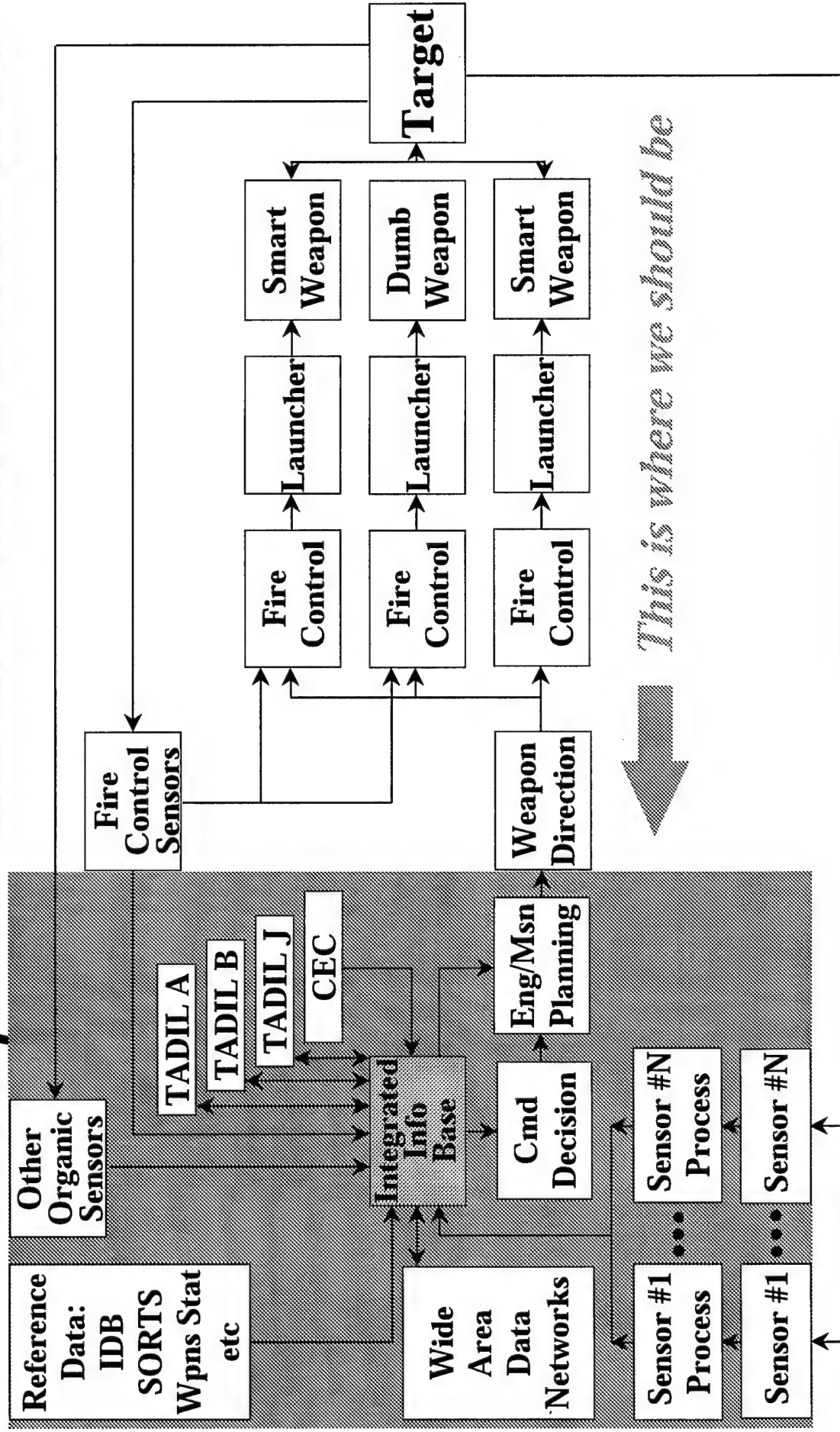
Information Integration is Our Future!!!



Putting "Ordnance on Target" with "Speed of Command"



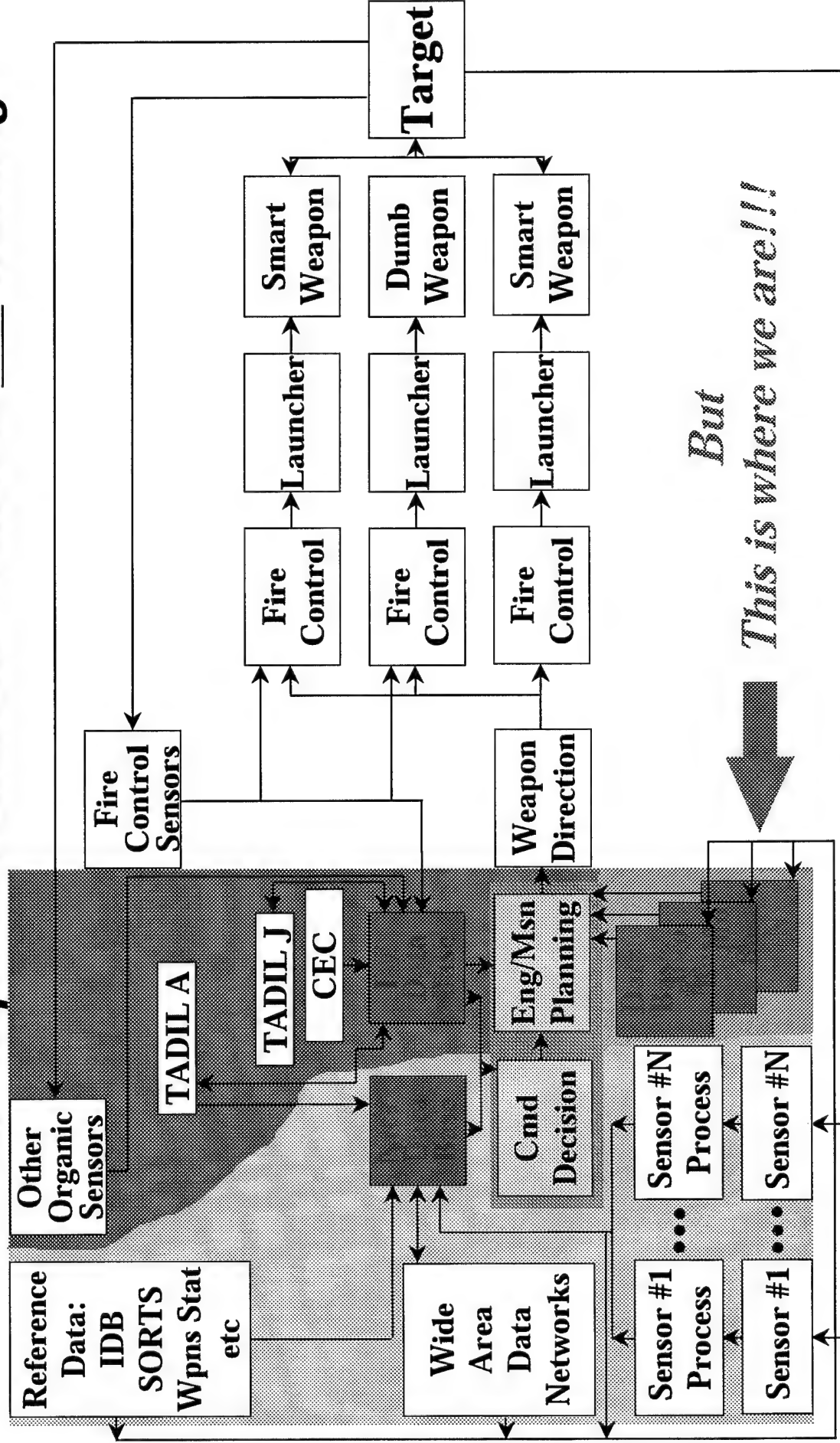
The Required Functions: How It Should Work





Putting "Ordnance on Target" with "Speed of Command"

The Required Functions: How It Is Not Working



*But
This is where we are!!!*

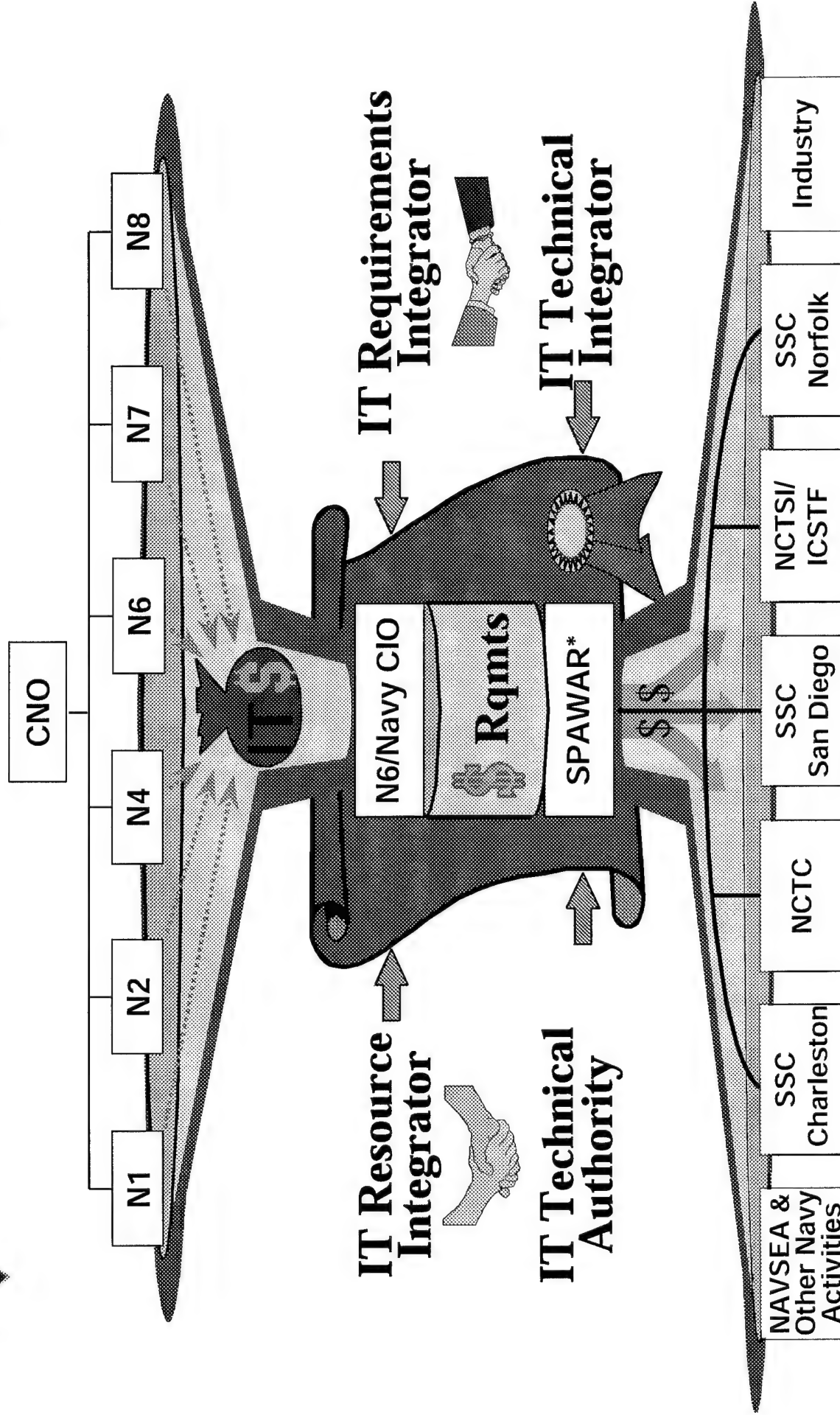


This Is Where We Are!!!

-
- The diagram illustrates a C4ISR architecture. It features a central processing area with several interconnected components. On the left, a box labeled "Reference Data: IDB SORTS Wpns Stat etc" provides input to the "Wide Area Data Networks". Above this, "Other Organic Sensors" and "Fire Control Sensors" also feed into the central area. Communication links labeled "TADIL A", "TADIL J", and "CEC" connect different parts of the system. On the right, "Weapon Direction" is an output. The central processing area includes a "Data Base", "Eng/Msn Planning", "Cmd Decision", and a series of sensor processing blocks labeled "Sensor #1 Process" through "Sensor #N Process". The "Wide Area Data Networks" also connects to "Sensor #1 Process" through "Sensor #N Process".

**We build interfaced, stovepiped systems
with non-interoperable data bases**

SPAWAR The Required Process & Authorities To Deliver End-to-End Capability



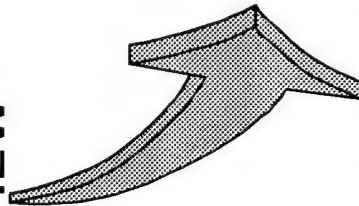


Summary

REQUIREMENTS AND FUNDING

OPNAV
SPONSORS'
VIEW

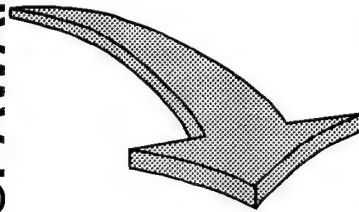
NCTC VIEW



ACQUISITION

ASN(RDA)
VIEW

SPAWAR VIEW



J	N	C	I	S	I	N	M	A	R	S	A	T	C	A	/	S	H	F	E	H	F	L	D	R	A	T	M	L	A	N	B	L	I	I
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

SYSTEM S INTEGRATION

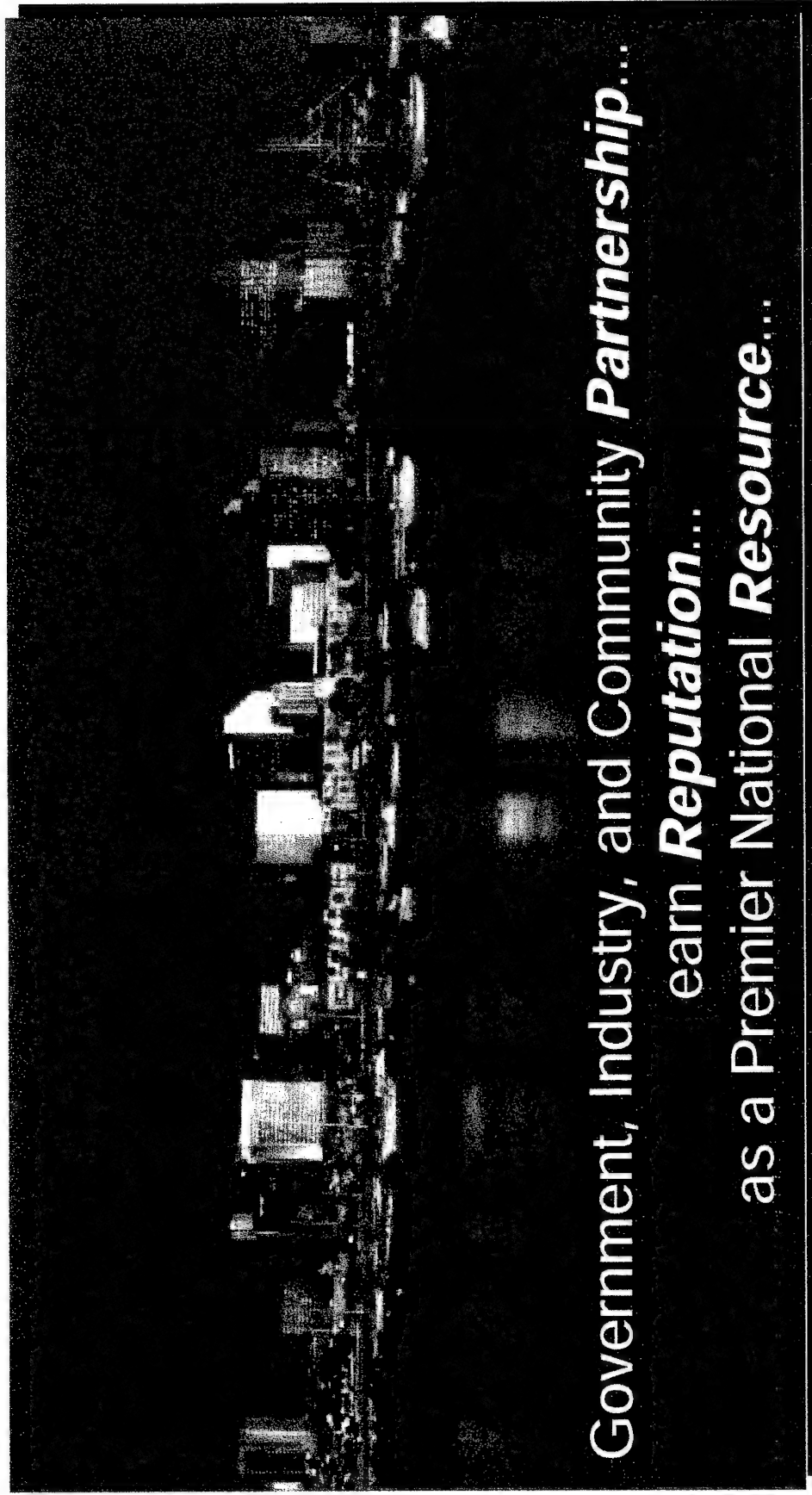
IT-21

NAVAL FORCES VIEW
Integrated Operational
Capability

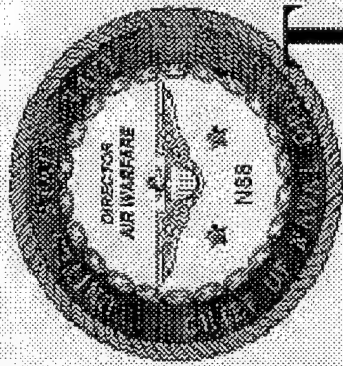
**INFORMATION TECHNOLOGY
FOR THE TWENTY-FIRST CENTURY (IT-21)**



Our Vision



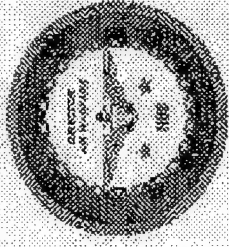
Government, Industry, and Community *Partnership*...
earn *Reputation*...
as a Premier National *Resource*...



Naval Aviation: “Leveraging Information Technology for the 21st Century”

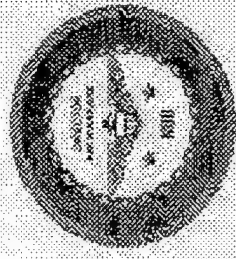
Rear Admiral “Carlos” Johnson
Aviation Plans and Requirements

Avionics for the 21st Century



- Trends
- Goals
- Avionics today
- Revolutionize avionics

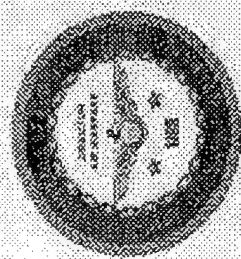
Avionics Trend



- “While 1% of the cost of a World War I combat plane was devoted to electronics, in World War II it was 10%, in the Vietnam War it was 35%, and now it’s 45%.”

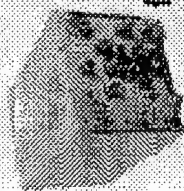
Norm Augustine
Chairman, Lockheed Martin

Federated Avionics Today



EGI

AYK-14s



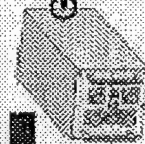
MC-1



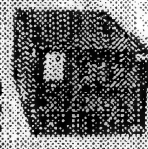
ATHS/IDM



ARC-210



GPWS



TAMMAC
AMU



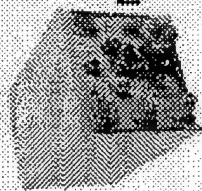
APX-100



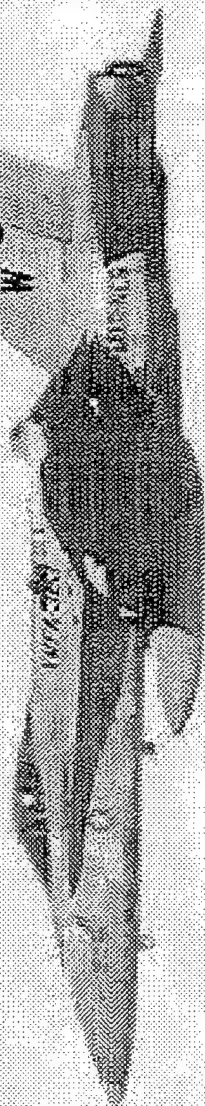
AMC&D



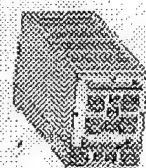
MC-2



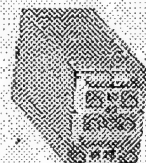
TAMMAC
DMS



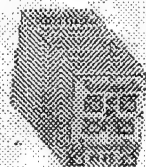
Where We Are Going Tomorrow



MCS

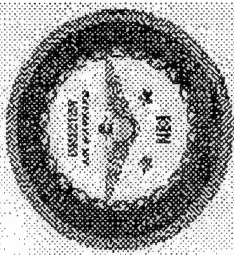


MGS



MMP

2000

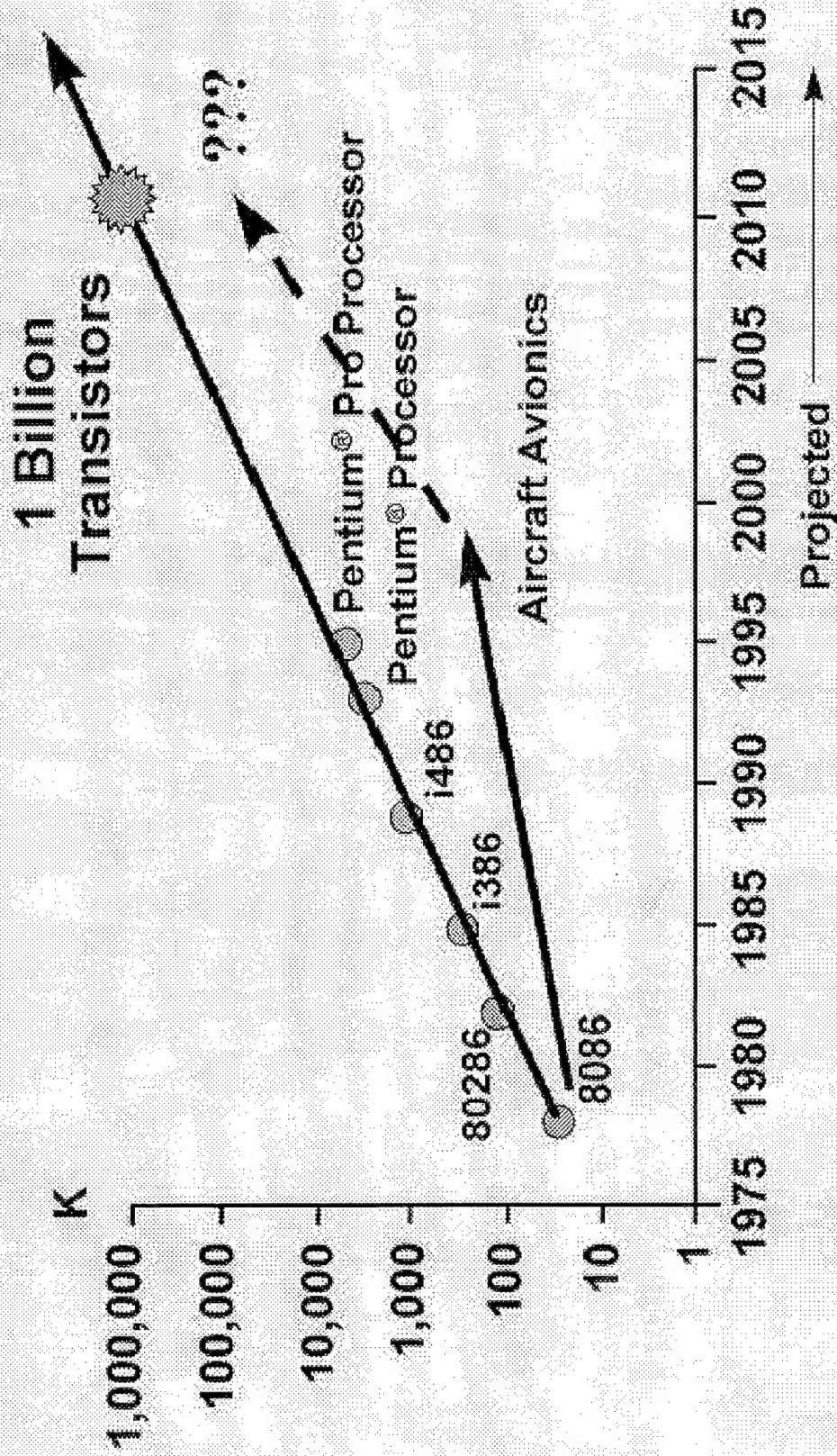
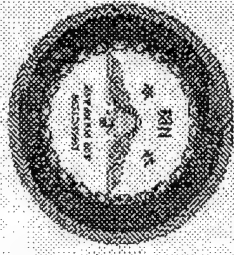


Goals

- Increase battlespace awareness
- Emphasize functionality of systems
- Leverage Commercial/Government Off the shelf Technology
- Plug and Play... then throw away
- Reduce life cycle costs
- Better, faster, cheaper

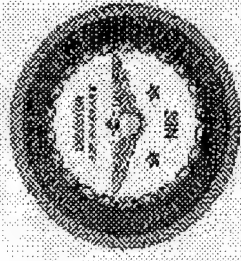
"We must leverage off the information revolution. If we don't our adversaries will. We must give the warfighter of the 21st century the tools to go in harm's way and prevail."

Defying Moore's Law



"Military aircraft avionics have not kept pace with commercial Information Technologies"

“Revolutionized” Avionics System Design is Needed

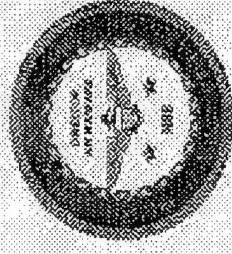


- Extremely capable, but
 - Establish standards for form, fit and function
 - Clearly define plug and play and open architecture
 - Modular, reusable “outerware” and software
 - New technology easily/affordably inserted to upgrade capability

*Transition from “legacy” systems will take
time and must be made affordable*

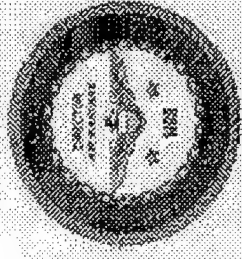
Example of Strategy

(AN/ARC-210(V) Acquisition Reform Initiative)



- Recognize Navy “standard” tactical airborne radio
- Long term partnership with Rockwell-Collins
 - 5 year CJ&A for sole source
- Leverages existing commercial technology
 - Reduces system cost by 19%
 - Increases reliability by 120%
 - Eliminates obsolescence
 - Provides viable path for future growth
- Five year failure-free reliability improvement warranty
 - Mitigates government risk
 - Guaranteed MTBF in the fleet
 - Eliminates “I” level maintenance requirements
- Total five year cost avoidance: \$65M

Summary



- Affordable strategy for legacy management
- Proactive modernization plan for the 21st century
- DoD and industry need to work together to deliver the most innovative and cost effective approach
 - Develop once and install across many platforms
 - Leverage other PMA/PMW/other services' investments
 - Establish long term business partnership with industry
 - » Maximize benefit of large procurement actions
 - » Leverage of industry investments
 - » Rapid infusion of commercial technology
 - » Significant reduce life cycle costs

NAVY SCIENCE AND TECHNOLOGY PROGRAM

THE RESOURCE SPONSOR PERSPECTIVE



HUGH E. MONTGOMERY, JR.
DIRECTOR, SCIENCE AND TECHNOLOGY DIVISION (N911)

SCIENCE & TECHNOLOGY DIVISION

(N911)

- S&T RESOURCE SPONSOR
 - POM INVESTMENT STRATEGY
 - PROGRAM DEFENSE
- S&T REQUIREMENTS
 - ROUND TABLES
 - REQUIREMENTS DOCUMENTATION
 - TECHNOLOGY INITIATIVES GAME (TIG)
- TECHNOLOGY TRANSITION
 - ATD PROCESS
 - INTEGRATED PRODUCT TEAMS

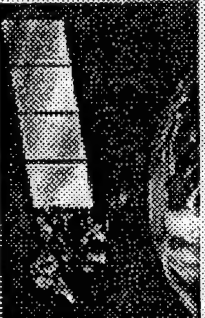
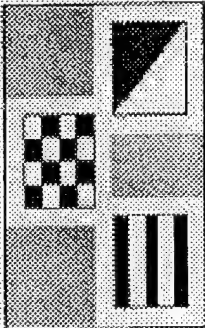
LOOKING TO THE FUTURE

- FUTURE IS POTENTIALLY VERY DIFFERENT FROM PRESENT
- AFFORDABILITY WILL BE A MAJOR DRIVER
 - NEED NEW WAYS OF DOING BUSINESS
- DOD/CONGRESSIONAL PROCESS MAKES NONLINEAR FUTURE DIFFICULT TO ACCESS
- EFFECT OF BALANCED BUDGET UNKNOWN

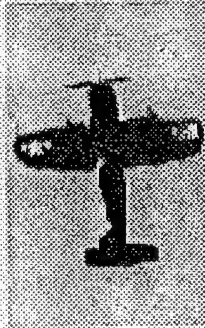
SCIENCE & TECHNOLOGY

WWII Vietnam Desert Storm

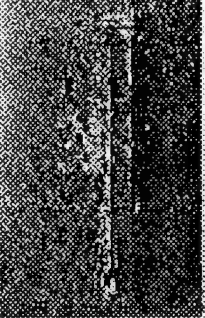
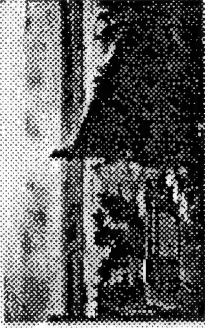
Command, Control
& Surveillance



Battlespace
Dominance



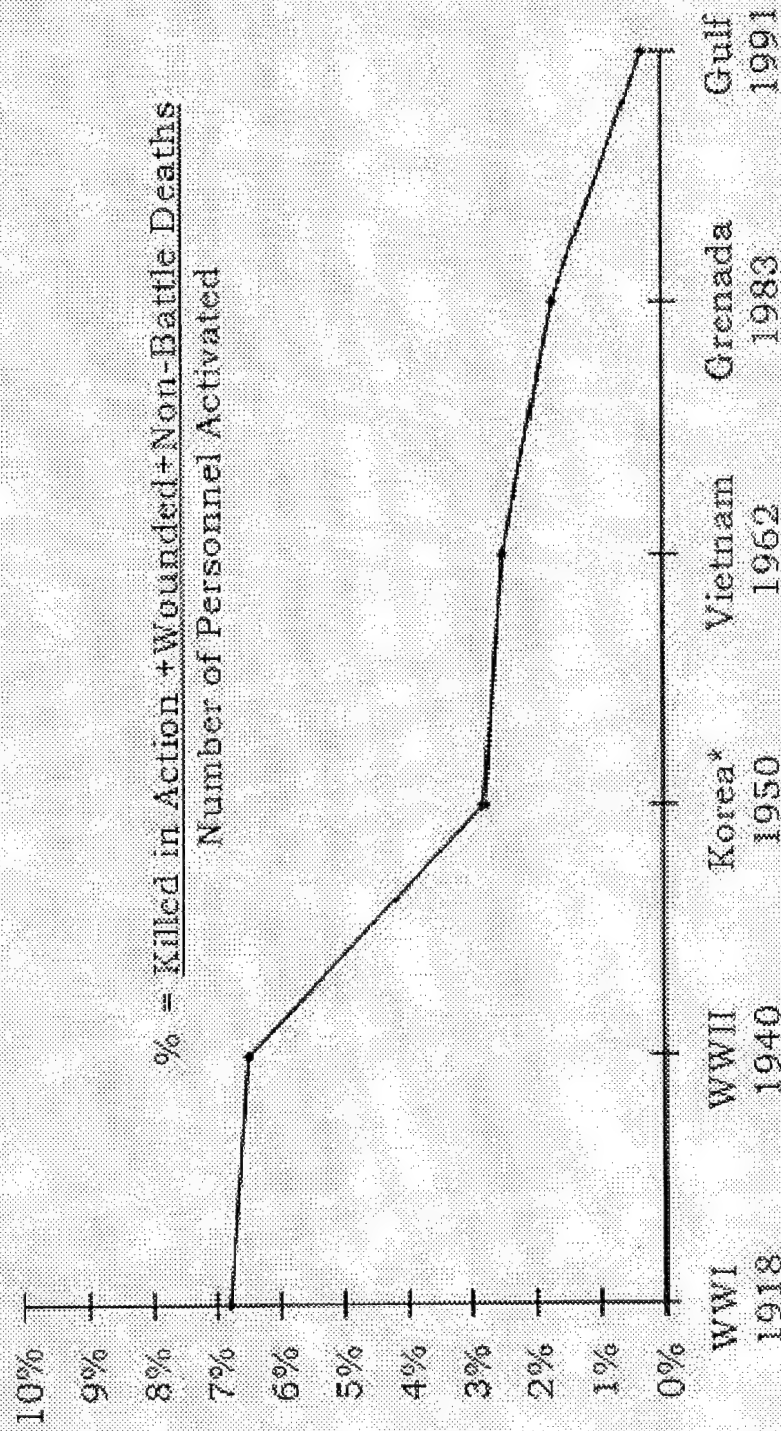
Force
Sustainment



Power
Projection



COMBAT CASUALTIES



Source: Army History Office

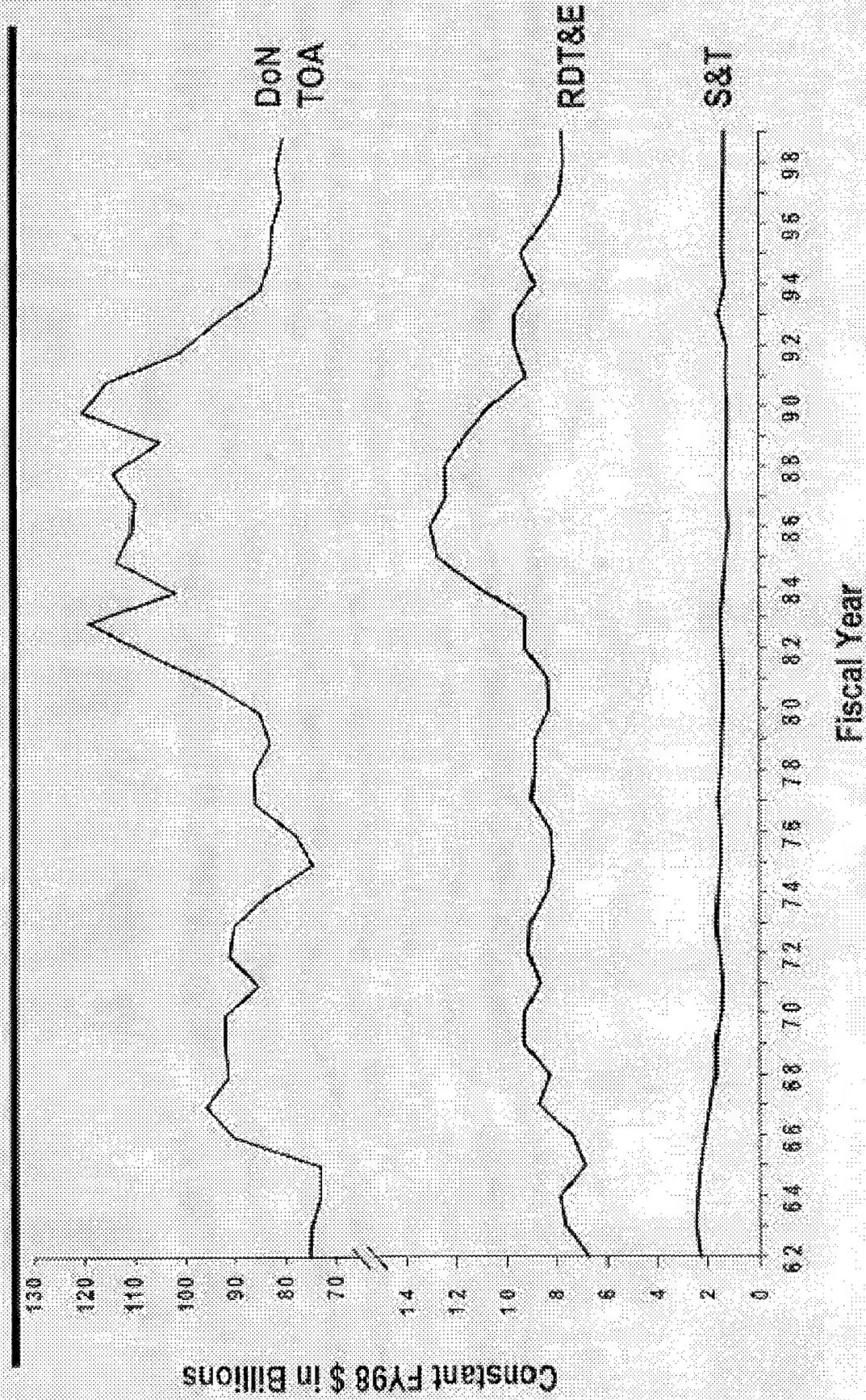
* Non-Battle Deaths Estimated

S&T ENVIRONMENT

- LEVEL OR REDUCED BUDGETS
- INCREASED JOINTNESS
- GREATER ACCEPTANCE OF COTS (MATURE TECHNOLOGY)
- INDUSTRIAL TEAMING INCREASING; BUT
 - BASIC RESEARCH DECLINE
 - DISMANTLED CENTRAL RESEARCH FACILITIES
 - RAPID COMMERCIALIZATION OF NEW TECHNOLOGY

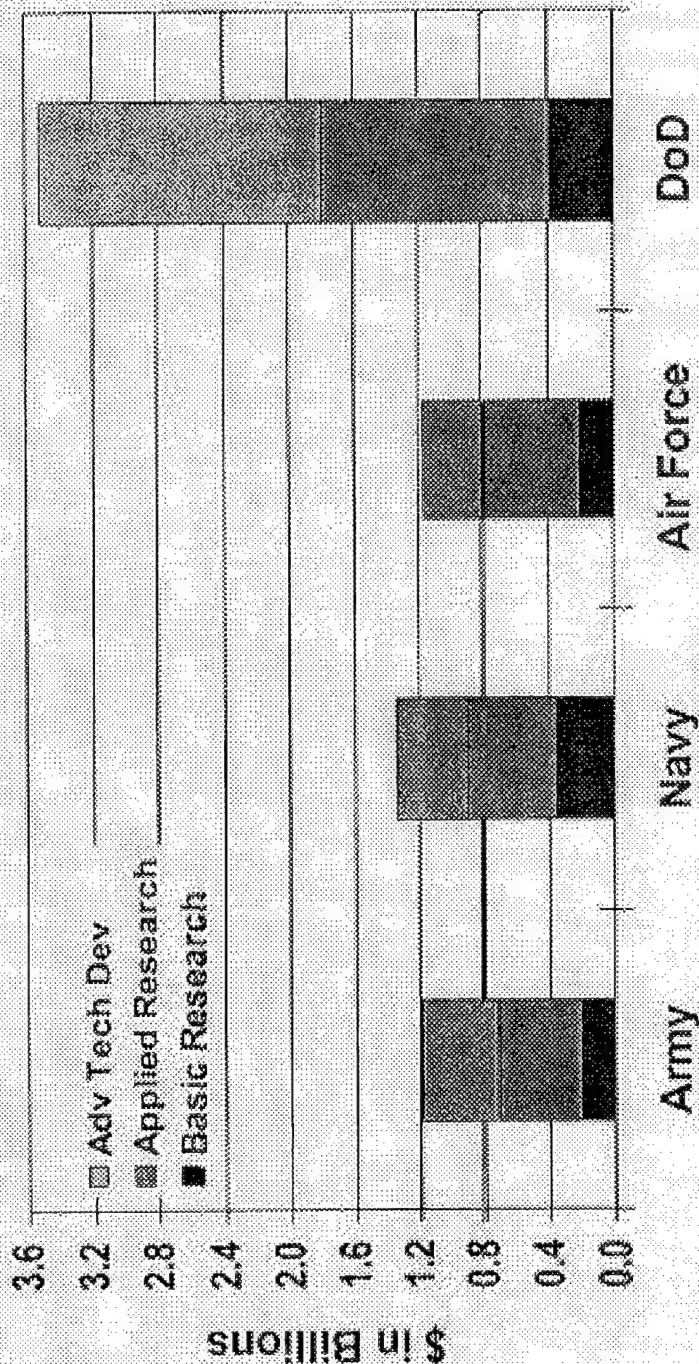
source: National Science Board, *Science & Engineering Indicators 1996*, Washington DC: US Government Printing Office, 1996 (NSB96-21), p. 4-10.

HISTORY OF DoN TOA, RDT&E AND S&T



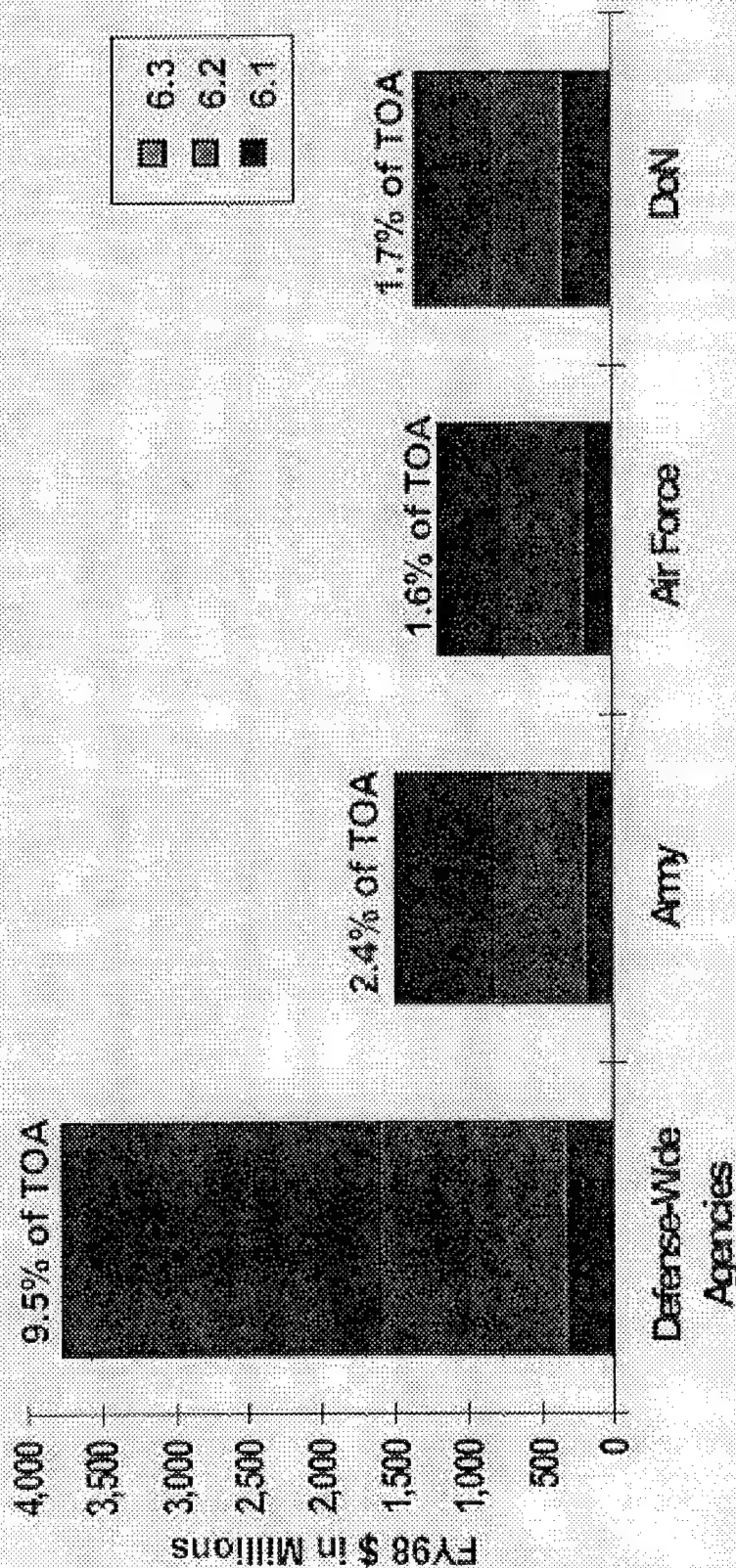
FY99 PRESIDENT'S BUDGET REQUEST FOR DoD S&T

Total FY99 S&T = \$7.2B



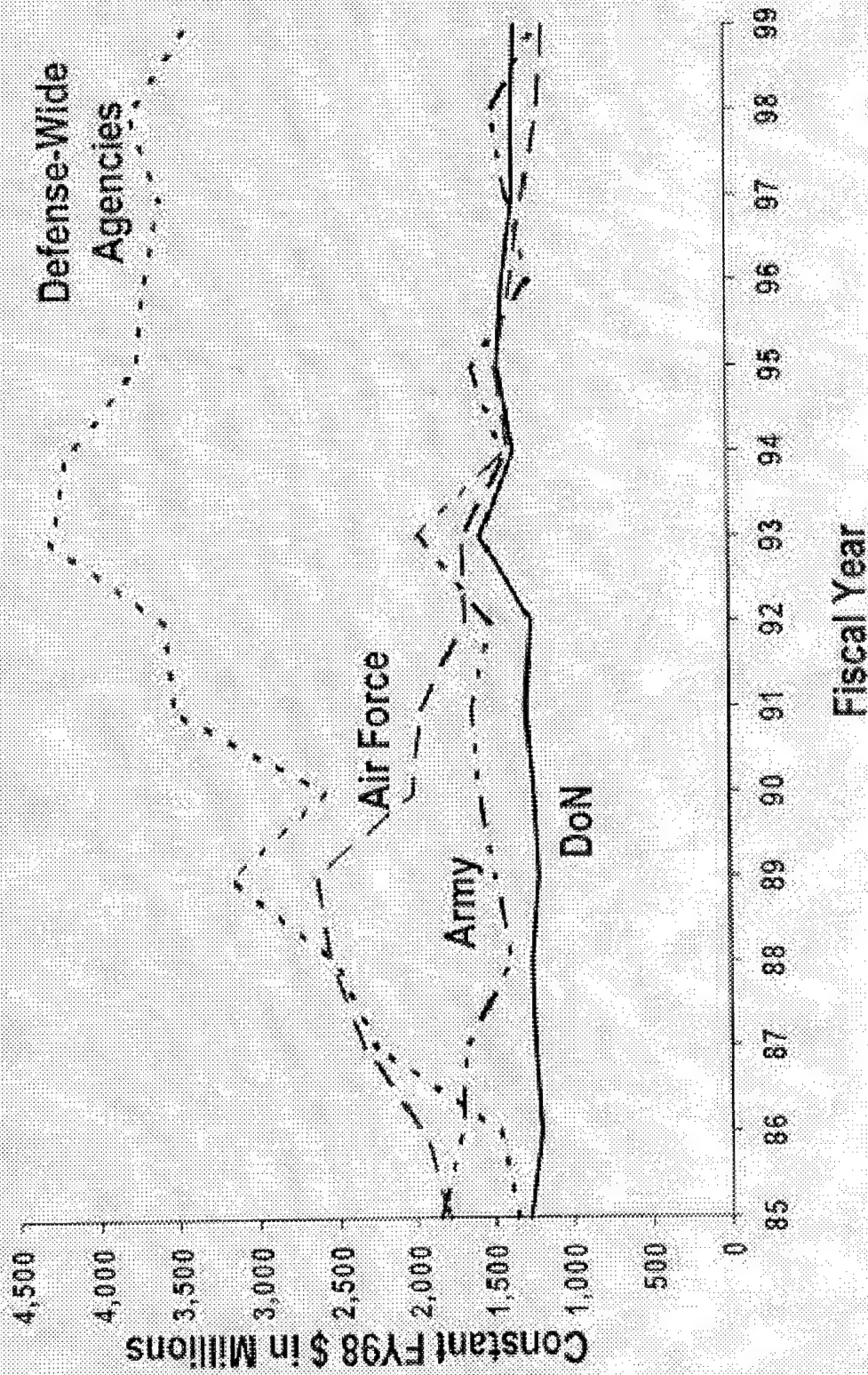
Source: DDR&E

DoD S&T FY98 INVESTMENT

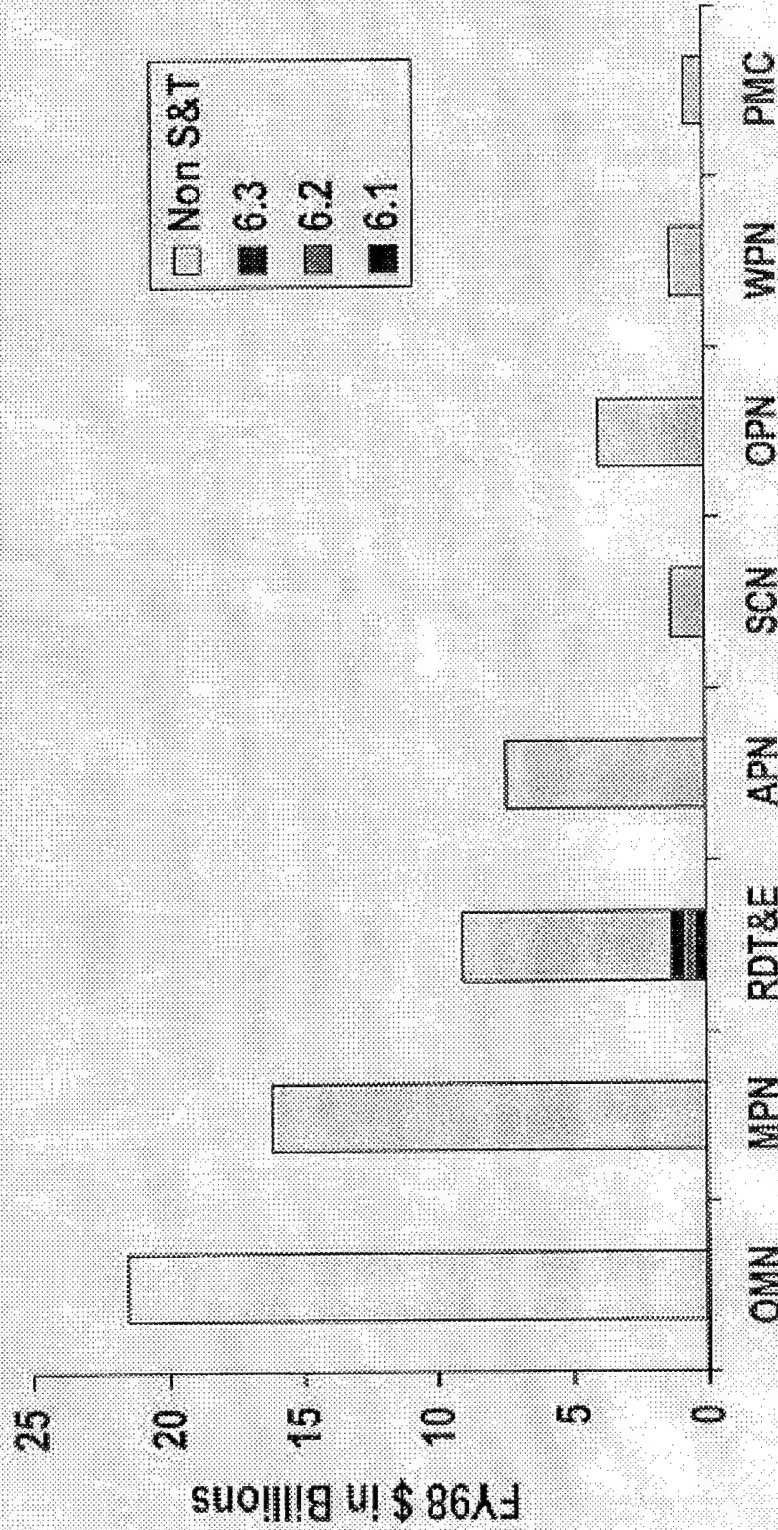


(OSD, BMDO, & ARPA)

COMPARISON OF DoD S&T ACCOUNTS



DoN FY99 PRESIDENT'S BUDGET



S&T PROGRAMMING TRENDS

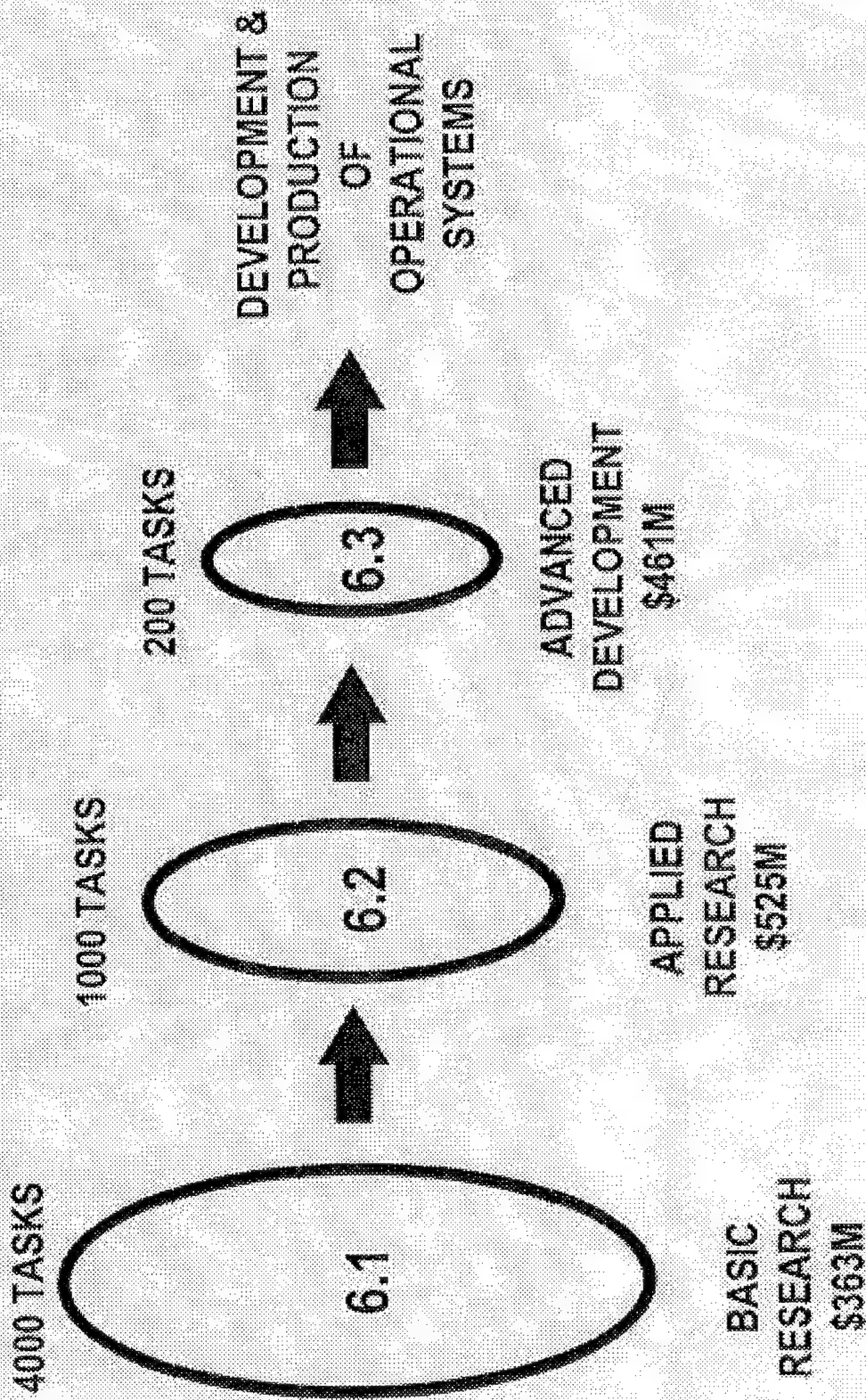
INCREASED EMPHASIS

- EXTENDING THE LITTORAL BATTLESPACE
- NETWORK CENTRIC WARFARE
- REDUCED MANNING
- AFFORDABILITY
- DD-21

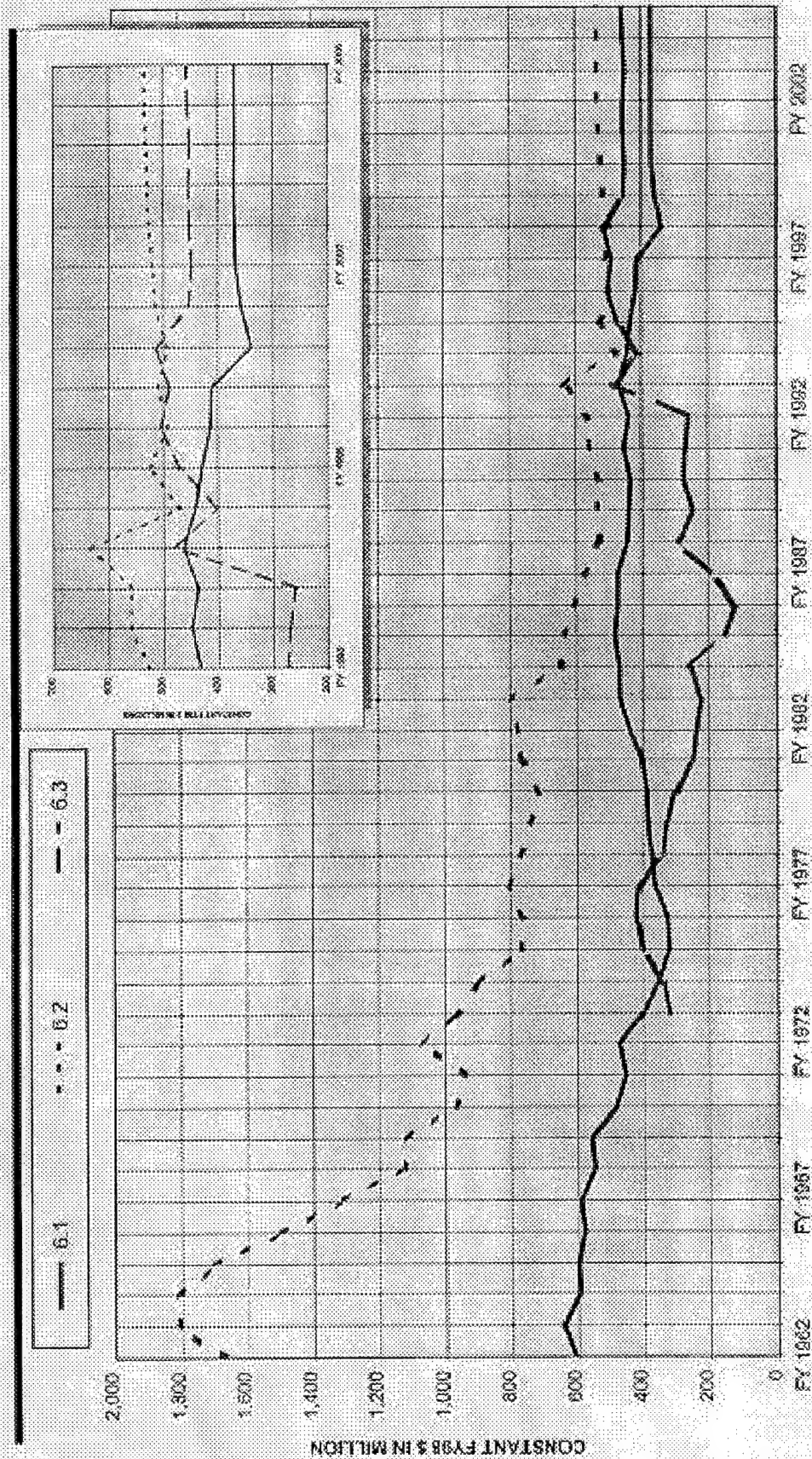
DECREASED EMPHASIS

- OPEN OCEAN/ARTIC ASW
- ANTI-SURFACE WARFARE
- ELECTRIC DRIVE

DoN S&T PROGRAM RELATIONS

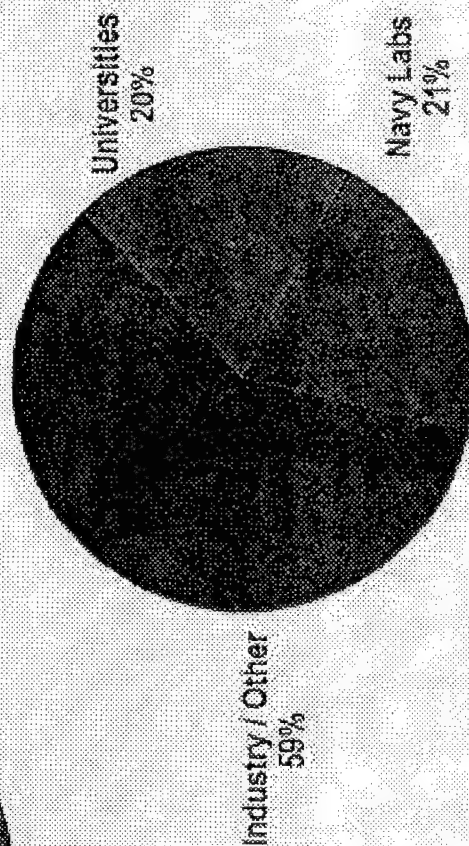
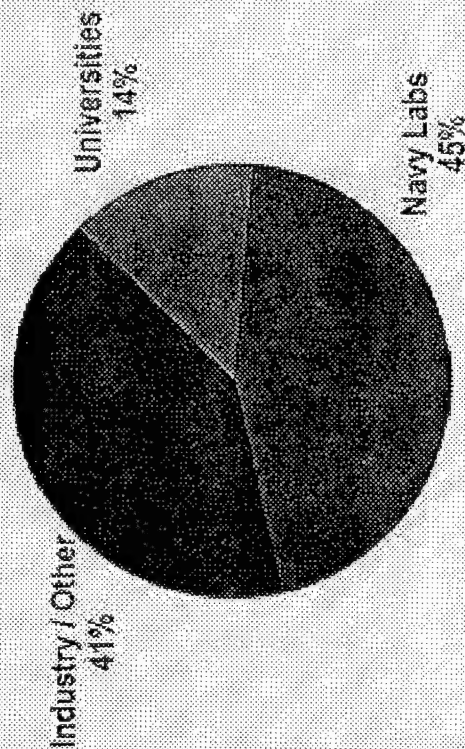
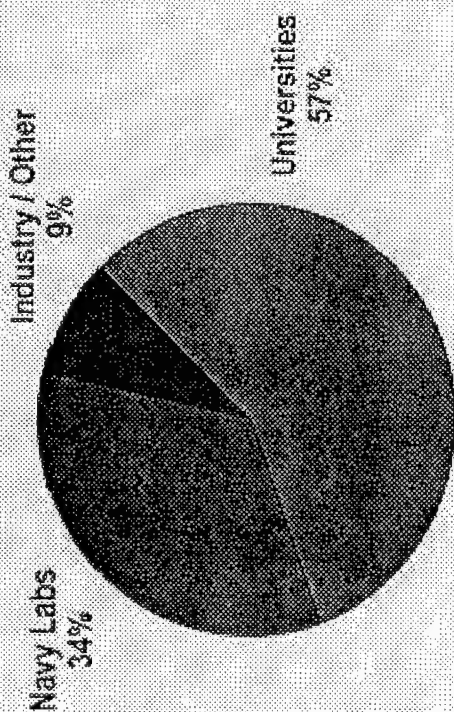


DoN S&T PROGRAM HISTORY



* FY00 - FY05 do not reflect SPP

DoN S&T FY98 BREAKDOWN



0.72

• WELCOME TO N091 •

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આવડેલા ત્રણ દિવસ પૂરવશમાંથી ૩૫૬ દુકાન

五五五

Science and Technology Division

李德全

Test and Evaluation System

五、

1. **अथर्ववेदः**

Scientific Publications (33/19)

Page 22 of 22

Boatlift Safety Erector

*Office of the Chief of Naval Operations
Director, Test and Evaluation and
Technology Requirements (N091)*

• WASHINGTON • EDITION 517574 •

<http://www.hq.navy.mil/n091>

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[illegible]

● N911 SCIENCE AND TECHNOLOGY DIVISION ●

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Director, Science and Technology Division (N911)

N911 HOSTER

CAPT Michael Lillenthal, USN

Deputy director, S&T Division (N911B)

1997
S&T REQUIREMENTS GUIDANCE (STRG)

Dr. James E. Andrews

Science and Technology Requirements (N911C)

1997 FORD TABLE
GENERAL INFORMATION

Ms Karen Ray

S&T Program Resources (N911D)

1998
FORD TABLE GENERAL INFORMATION

Dr. Michael Marron

Chief Scientist (N911F)

S&T RELATED LINKS

Lt. COL Dennis Beal, USMC

Expeditionary Warfare Technology Programs (N911M)

TEST GENERAL INFORMATION

Mr. Dan Goldstein

S&T Assessment (N911T)

Ms Nancy Thomas, Secretary (N911S)

Voice: 703-601-1780

Fax: 703-601-2050/2055

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● SCIENCE & TECHNOLOGY RELATED LINKS ●

-
- Please make your selection by pressing one of the nine buttons shown below ●

NATIONAL SECURITY S & T STRATEGY

JOINT VISION 2010

DEFENSE S & T STRATEGY

JOINT WARFIGHTING CAPABILITY OBJECTIVES

DEFENSE TECHNOLOGY OBJECTIVES

DEFENSE TECHNOLOGY AREA PLAN

DEFENSE BASIC RESEARCH PLAN

FORWARD... FROM THE SEA

BACK TO CNO-N051 HOME PAGE

NAVY ADVANCED TECHNOLOGY DEMONSTRATIONS (ATDs)

- NAVY CREATED ATDs IN FY87
- TRANSITION OF HIGHEST PAYOFF TECHNOLOGIES
- RISK REDUCTION
- REQUIREMENTS DRIVEN
- FINITE DURATION
- TRANSITION PLAN
- RIGOROUS SELECTION AND REVIEW PROCESS

ADVANCED CONCEPT TECHNOLOGY DEMONSTRATIONS

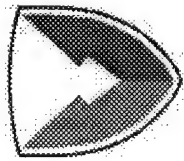
- NEXT STEP BEYOND ATDs
- TRANSITION LOWER RISK JOINT TECHNOLOGIES
- FIELDABLE PROTOTYPE LEGACY
- SERVICE FUNDING

FY99 ISSUES

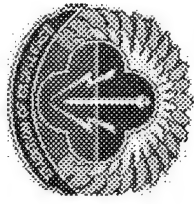
- S&T INVESTMENT
 - S&T DID NOT SHARE IN THE REAGAN BUILDUP; HEAVY PRESSURE TO DECREASE
 - 6.1 REDUCED BY CONGRESS IN FY98
 - 6.2 IN 30 YEAR DECLINE
- CONGRESSIONAL ISSUES
 - S&T PROGRAM STABILITY
 - BALANCED BUDGET IMPACTS
 - CONGRESSIONAL REBALANCING OF PROGRAM
 - ATD FUNDING LEVEL
 - VECTOR
- OUTSOURCING
 - INCREASING INDUSTRY SHARE OF S&T
 - MINIMAL IR&D PROGRAM VISIBILITY
 - ROLE OF IN-HOUSE R&D FACILITIES

S&T BOTTOM LINE

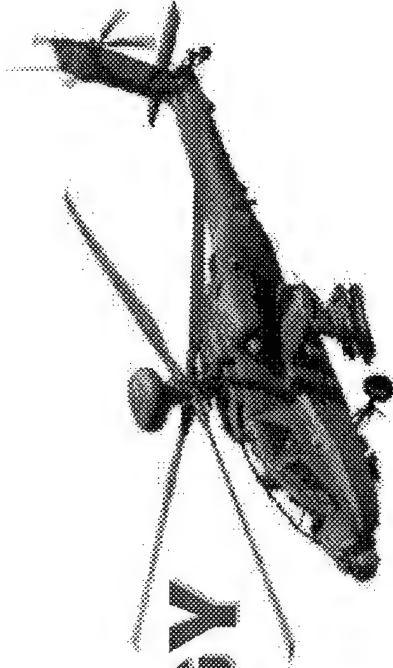
- LOW THREAT ALLOWS INCREASED FOCUS ON S&T (5-20 YEAR HORIZON)
- LOW INDUSTRY / ACADEMIA S&T INVESTMENT
- DoD S&T INVESTMENT DOWN, ESPECIALLY IN 6.3
- TWO MANAGEMENT CHOICES:
 - INCREASE FUNDING
 - INCREASE FOCUS



JOINT SERVICES AVIONICS (JSA)

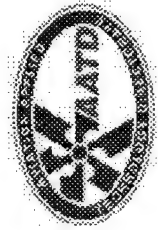


ARMY TECHNOLOGY THRUSTS

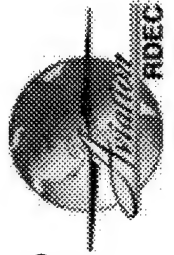


BRIEFING TO INDUSTRY 17 JUNE 1998

JOHN MACRINO
Chief, Mission Equipment Integration Division
AVRDEC-AATD
AMCOM
757-878-2122



CRIS TSOUBANOS
Chief, Technical Integration Division
AVRDEC-DAS
AMCOM
256-313-2399



P-TI-169-98

030

Aviation Vision



DOMINANCE
LAND FORCE

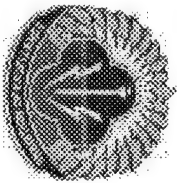
Lethal

*Joint
Precision
Response*

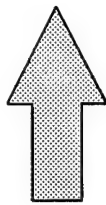
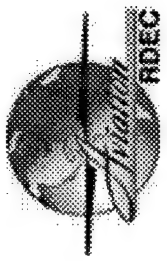
Non-Lethal

*Versatile
Flexible
Modular
Deployable
Sustainable*

A Relevant Force for the Future



ARMY TECHNOLOGY THRUSTS AGENDA



CURRENT PROGRAMS

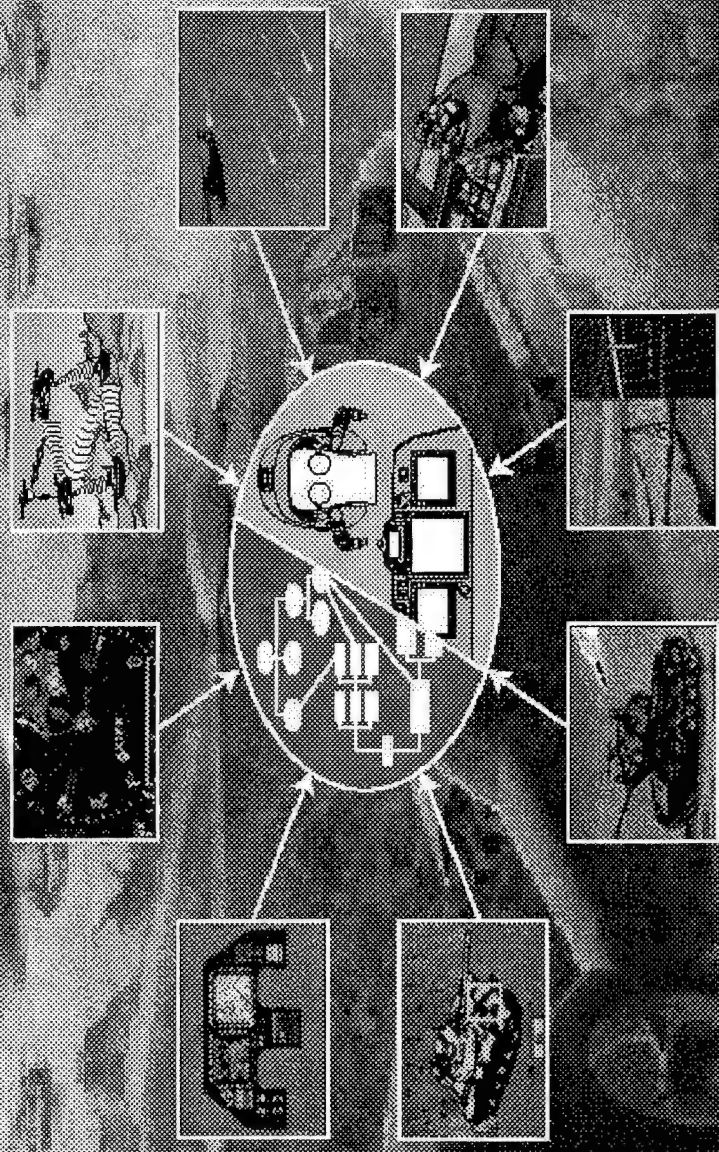
Rotorcraft Pilots Associate (RPA)
Airborne Manned/Unmanned System Tech Demo
(AMUST)



PLANNED PROGRAM

Helicopter Integrated Low-cost Avionics Demo
(HILAD)

Rotorcraft Pilot's Associate ATD



P-TDRP-96-153-2A

P-TDRP-96-153-2A

RPA FUNCTIONAL OVERVIEW

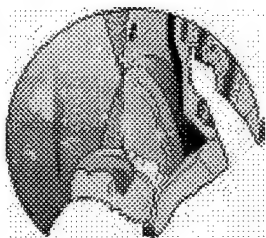
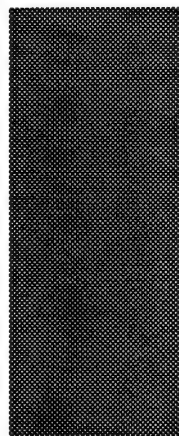
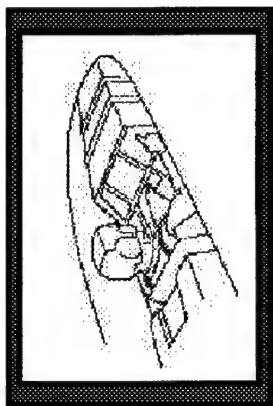


Knowledge based *ASSOCIATE* system for cognitive decision aiding

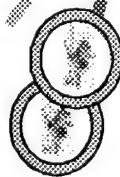
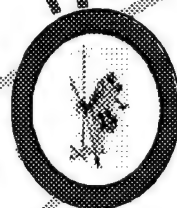
An application of artificial intelligence, advanced computing techniques, and next generation controls and displays which will provide real time:

- Automated continuous mission planning (routes, battle positions, observation points, etc.)
- Comprehensive utilization of digital battlefield information
- Automated, context sensitive reconfiguration/control of mission equipment
- Efficient and intuitive cockpit information management
- Greatly improved situation awareness
- Synchronization of team operations and management of assets

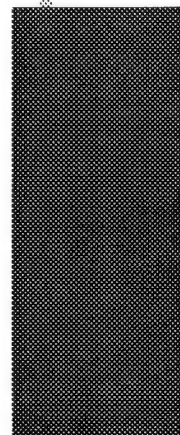
Realtime Computer-aided Decision Making



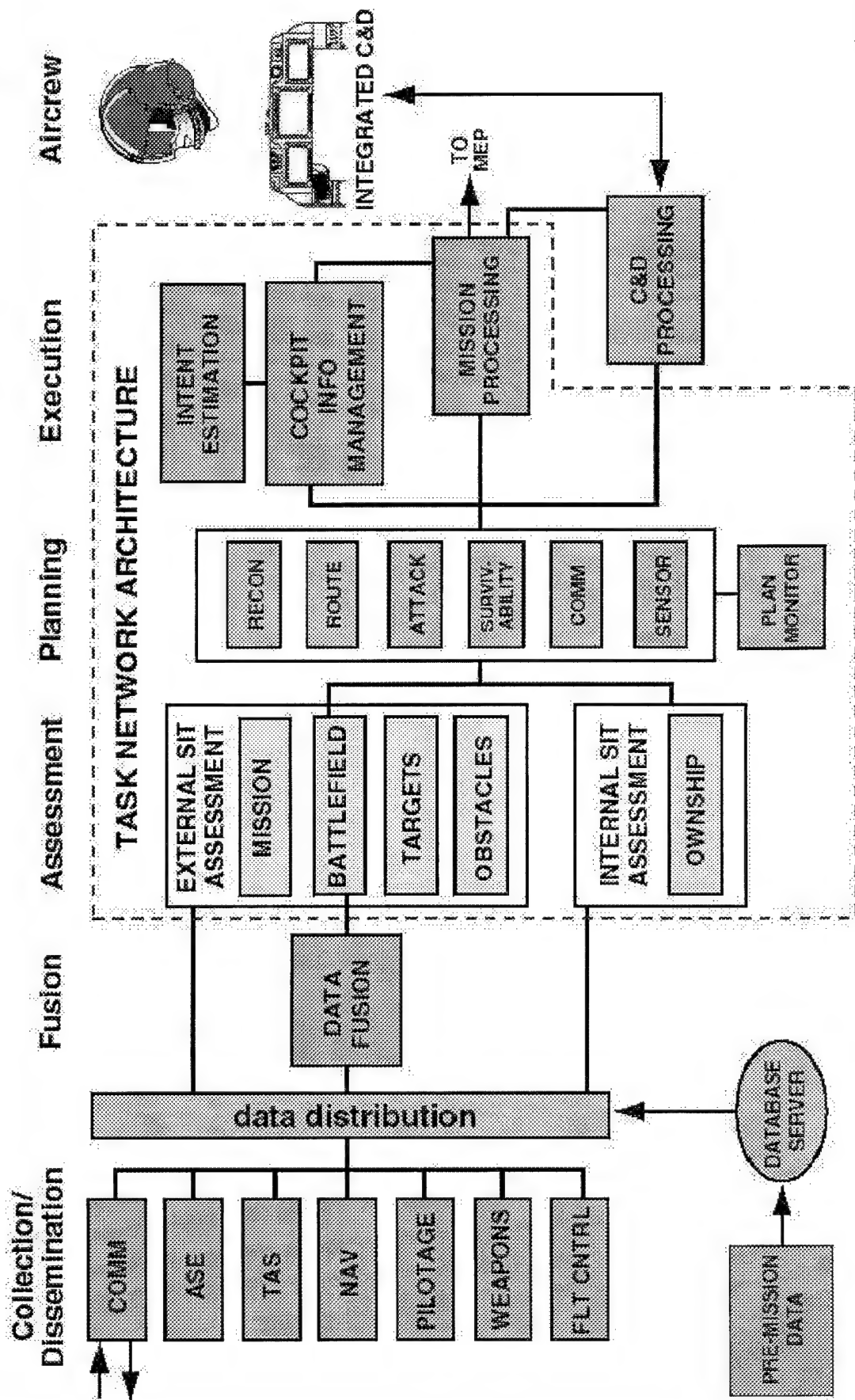
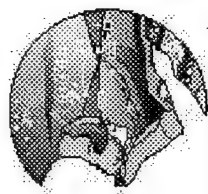
RPA



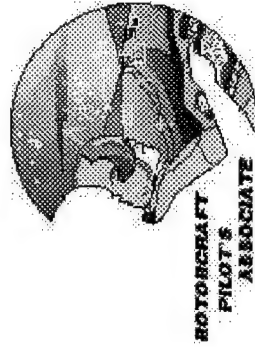
Ownship and
Team Utilization



MISSION MANAGEMENT



PROGRAM GOALS



MEASURES OF EFFECTIVENESS (MOE'S)

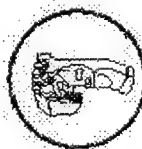
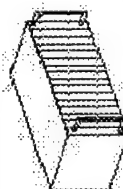
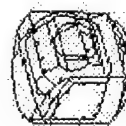
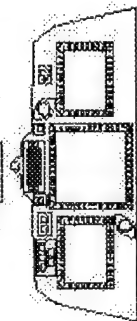
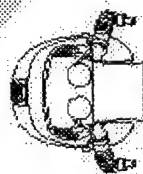
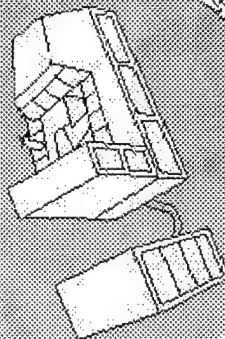
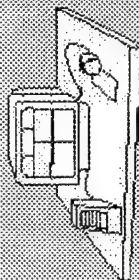
CHARACTERISTICS	EXIT CRITERIA	GOAL
Reduction in mission losses	30%	60%
Increased targets destroyed	50%	150%
Reduced mission timelines	20%	30%

(Comanche-Like MEP Baseline)

RPA EVALUATIONS



Concepts

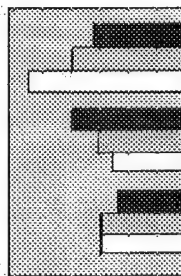


**Advanced Mission
Equipment**

plus

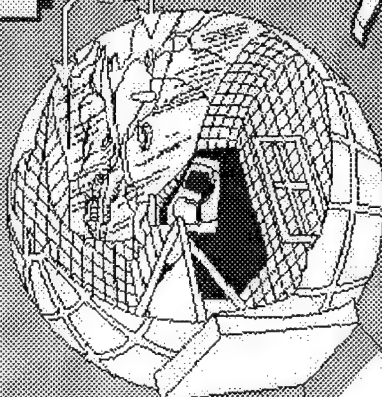
**Rotorcraft
Pilot's
Associate**

**Human
Performance**



Rapid Prototyping

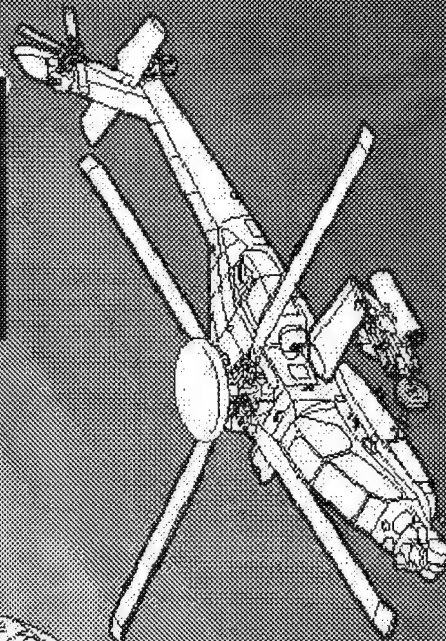
Proof-of-Concept



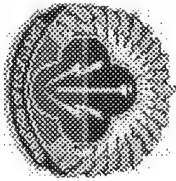
BACKGROUND
VIDEO

INSET VIDEO

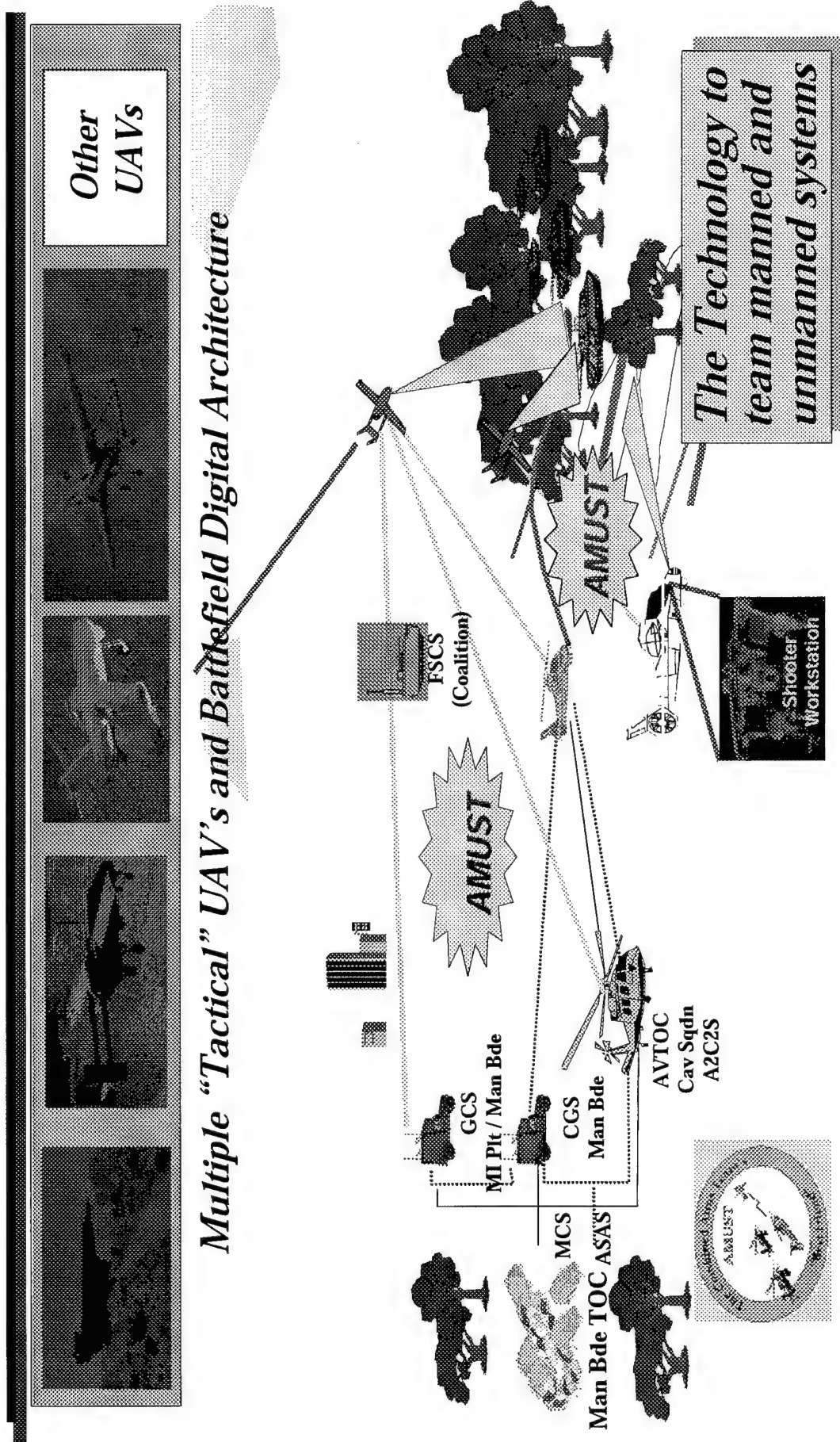
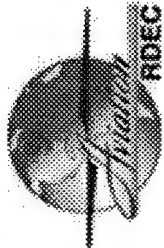
Validation

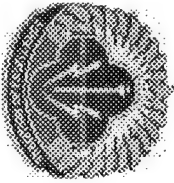






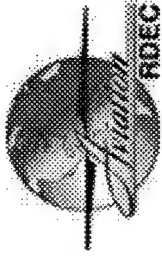
Airborne Manned/Unmanned System Technology (AMUST)



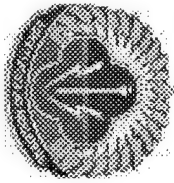


AMUST-D

Technical Objective



Demonstrate through simulation and flight tests the control mechanisms, intelligent linkages and integration architectures to allow Manned Air Vehicle/Unmanned Air Vehicle (MAV/UAV) system to operate as an effective warfighting system of systems to increase the combined arms team battlefield effectiveness

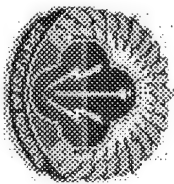


AMUST-D Pay-offs

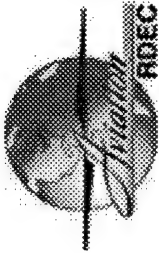


What are you getting for your money

- Improved operational effectiveness
- Increased operational efficiency
- Increased survivability
- Improved target acquisition
- Improved situational awareness
- Increased mission flexibility
- Maximize use of weapons stand-off range
- Real-time Battle Damage Assessment (BDA)
- Frequency Spectrum Management
- and more...



AMUST-D



Leveraged Technologies

CECOM Sensors

- >Multi-Mission Common Modular UAV Sensor
- >Advanced sensor efforts

CECOM Communication

- >Non-line-of-sight communications
- >High band width communication efforts

AMUST 6.2 STO

- >Trade-off Study
- >Sensor & Vehicle Evaluation
- >Real time information assessment
- >Functionality Assessment

TRADOC CEP

- >Effectiveness
- >Operational Evaluation
- >ITPs
- >Control Relationships

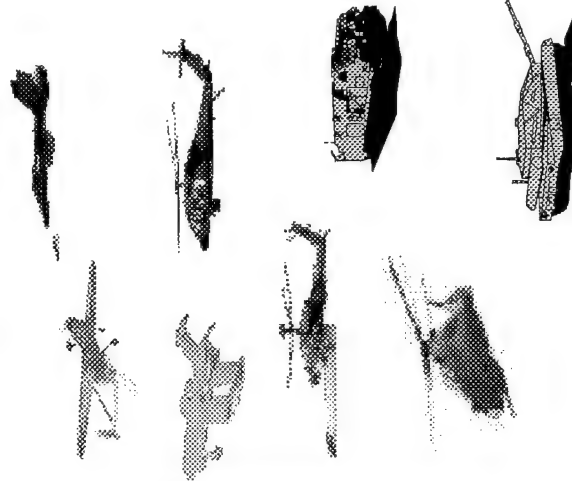
AMCOM RPA

- >Cognitive Decision Aiding
- >Mission Planning
- >Data Fusion

UAV JPO

- >Outrider
- >Hunter
- >Tactical Control Station
- >Sensor & Vehicle

PEO/PM Upgrades

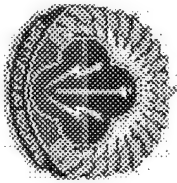


AMUST-D

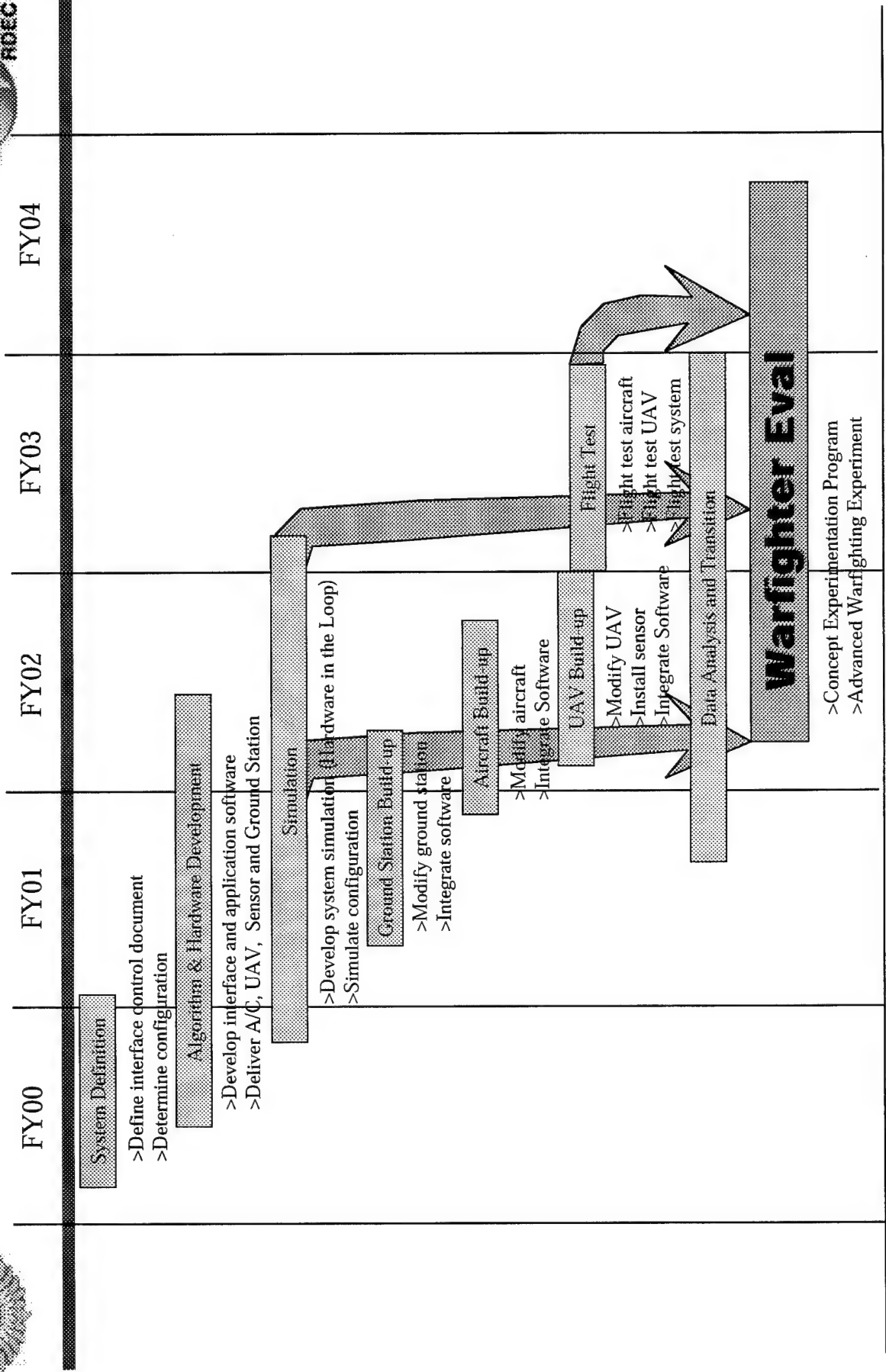
- >System Definition
- >Algorithm & Hardware Development
- >Simulation
- >Ground Station Build-up
- >Aircraft Build-up
- >UAV Build-up
- >Flight Test
- >Data Analysis and Transition

Warfighter Eval

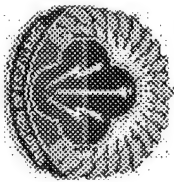
- >Concept Experimentation Program
- >Advanced Warfighting Experiment



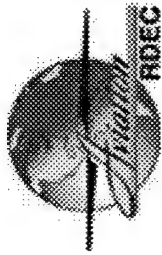
AMUST-D



904



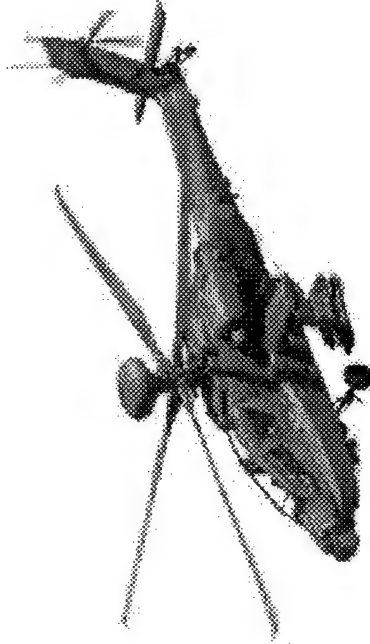
ARMY TECHNOLOGY THRUSTS R&D VIEW TODAY Avionics Architecture



DUAL 1553 B VIDEO AND HIGH SPEED BUSES



JIAWG(-) ICNIA(-)



FEDERATED (+)

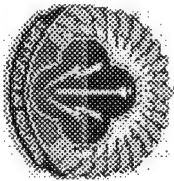


OSD MANDATED OPEN SYSTEMS ARCHITECTURE

– JOINT TECHNICAL ARCHITECTURE – JTA

– JTA-A

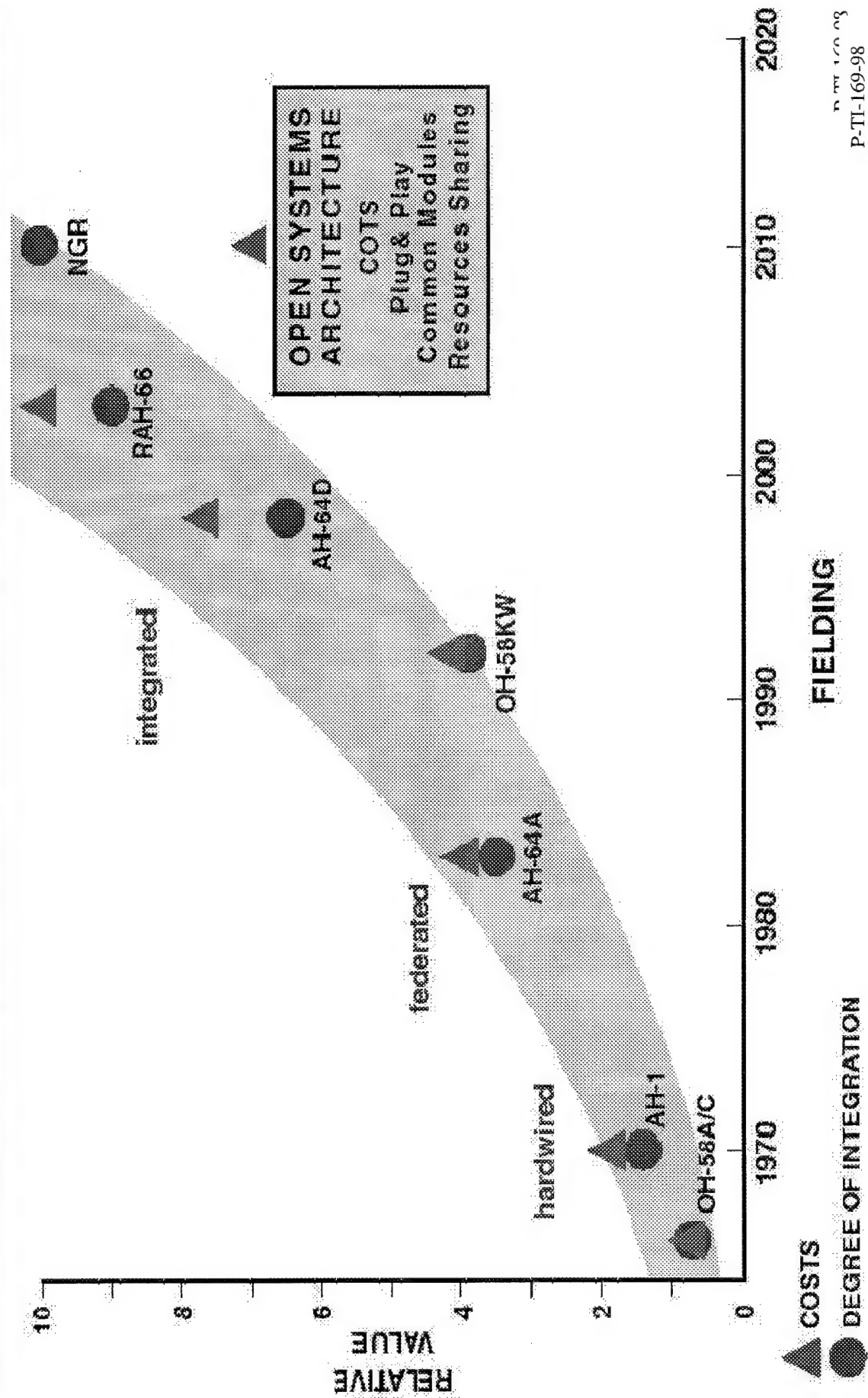
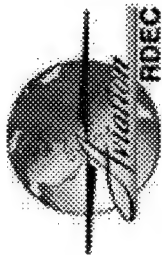
Affordability – Major Issue

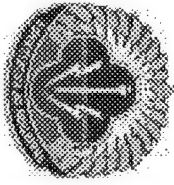


ARMY TECHNOLOGY THRUSTS

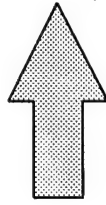
HELICOPTER AVIONICS INTEGRATION

Scout/Attack



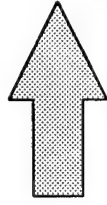


ARMY TECHNOLOGY THRUSTS S&T STRATEGY



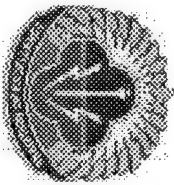
MISSION EQUIPMENT TECHNOLOGY DEVELOPMENT

- SENSORS, WEAPONS/ARMAMENT, COMM/NAV, DISPLAYS, ETC.
- EMPHASIS ON MULTI-PLATFORM APPLICATIONS - HTI



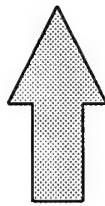
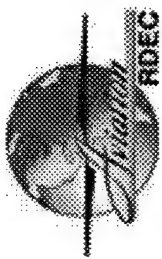
PLATFORM ELECTRONIC ARCHITECTURE

- EFFECTIVE INTEGRATION OF MISSION SUBSYSTEMS (MS)
- ENHANCE VEHICLE PERFORMANCE WITH EFFECTIVE
INTEGRATION OF PLATFORM SUBSYSTEMS AND MS



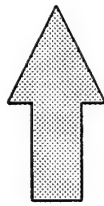
ARMY TECHNOLOGY THRUSTS

Helicopter Integrated Low-cost Avionics Demo (HILAD)



LEVERAGE AF, NAVY, AND DAPRA OSA DEVELOPMENTS

- ISS/JSF, MAST, VITAL, ETC.

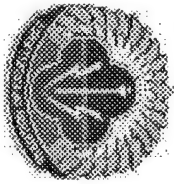


ADAPT OSA TO ROTORCRAFT UNIQUE REQUIREMENTS

- NOE ENVIRONMENT
- FAULT & BATTLE DAMAGE TOLERANCE
- DIGITAL BATTLEFIELD REQUIREMENTS

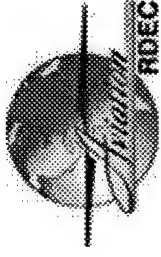


PE 063003 DB97 - AVIONICS INTEGRATION



ARMY TECHNOLOGY THRUSTS

HILAD



REQUIREMENTS

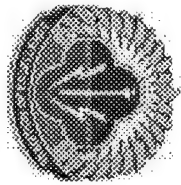
- JTA-A
- COTS
- COMMON MODULES
- PLUG & PLAY
- REUSABLE SOFTWARE

GOALS

- 30% REDUCTION IN WEIGHT, COST, & POWER
- 35% IMPROVED MISSION RELIABILITY & BATTLE DAMAGE TOLERANCE
- 35% INCREASE IN SITUATIONAL AWARENESS & NOE TARGET OPPORTUNITIES
- 50% INCREASE IN OPTEMP ON DIGITIZATION BATTLEFIELD

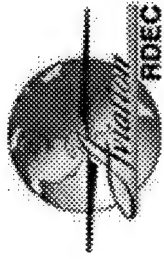
OBJECTIVE

Develop next generation rotorcraft electronic architecture standards, specifications, avionics interface criteria, and demonstrate emerging integration technologies



ARMY TECHNOLOGY THRUSTS

HILAD



	00	01	02	03	04	05
PHASE I Simulation/ Virtual Prototyping	SUBSYS/SYSTEMS DEMO <ul style="list-style-type: none"> ● OPEN SYSTEM ARCHITECTURE ● FAULT & BATTLE DAMAGE TOL. ● COTS ● PLUG & PLAY ● REUSABLE SYSTEM SW 					
				MISSION CAPABLE DEMO <ul style="list-style-type: none"> ● NOE TACTICAL DATA FUSION ● ADVANCED COMM ● NOE SITUATIONAL AWARENESS ● REUSABLE MISSION S/W 		
PHASE II Hot Bench/ Flight Demo						

TI-97-27-16

P-TI-169-98

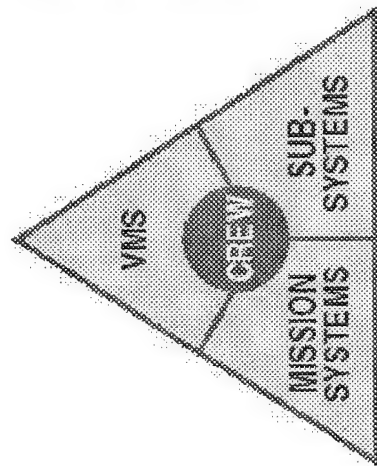
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INTEGRATED PLATFORM ELECTRONICS THRUST AFFORDABLE DIGITAL AVIONICS

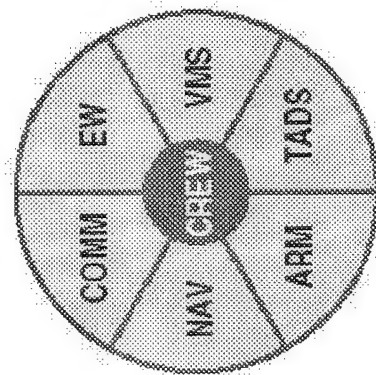
TODAY

TOMORROW

ARMY AFTER NEXT



F-22 RAH-66



FA-18 AH-64

INTEGRATION

MISSION SYSTEMS - JSF/MAST

Open Arch
Reliability
Common H/W-SW
Std Interface
COTS

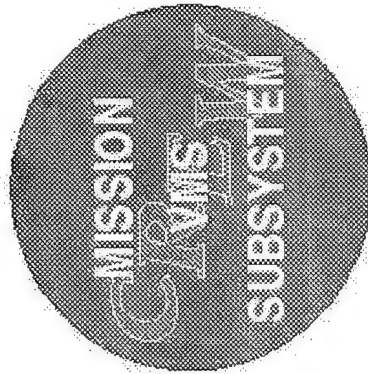
VEH MGT SYSTEM - FLASH/VITAL

Open Arch
Fault Tolerant
Common H/W-SW
Std Interface
COTS

SUBSYSTEMS - MEI

POWER-BY-WIRE

**MISSION
FLEXIBILITY/VERSATILITY**



**REDUCE \$
RDT&E, PROC, O&S**

Title: Changing Requirements For EW Threat Simulation

Presenter: Dr. Edward G. Eberl, Vice President, Amherst Systems Inc.

Track: SOS TSG

Changing Requirements For EW Threat Simulation

1. Introduction

This paper represents my own observations based on recent procurement and contract activity engaged in by Amherst Systems. It is not the result of a scientific survey. No requirement is intended to be associated with a specific system under test or program. These observations are based on many recent requests for proposals and contracts which Amherst Systems has been exposed to. As a leading manufacturer of EW threat simulators for all applications (RWRs, Jammers, ELINT receivers, etc.), Amherst Systems is in a unique position to be aware of many current and future requirements. While we have not won every contract, we have had the opportunity to bid on every major program and thus have been exposed to the most stringent simulation requirements.

1.1. A Few Basics

An EW threat simulator performs three basic functions. The first step is the generation of the radar's transmit waveform. This requires the generation of an RF waveform with the appropriate PRI, frequency, pulse, and scan characteristics. This waveform represents the RF signal as it leaves the transmit antenna. The second function is the modeling of the environmental effects as the waveform travels from the transmitter to the receiver. This model takes into account all factors which affect the electromagnetic wave as it travels from the transmit antenna to the receive apertures on the system under test. The final step is to model the aperture and receiver effects as the waveform is measured by the system under test.

2. Early Simulation Technology

In the infancy of the EW threat simulation industry, there were a few basic requirements to be met. Pulse train generation consisted of simple PRI and pulse width. Geometry and motion simulation was limited to simple straight and level flight in a flat earth environment updated at 1 Hz. A basic radar range equation was used, resulting in a simple $20 \log R$ range loss. The RF signals were typically generated using noisy VCO RF sources with coarse frequency resolution. Modeling of the system under test was implemented by a generic receiver model which generated 4 amplitude controlled signals for injection into an amplitude comparison DF receiver. While all of this may sound quite limited by today's standards, it represented the state of the art at the time. It was also sufficient given the level of sophistication of radar warning receivers at that time.

3. Factors Pushing EW Threat Simulator Requirements

In today's environment, there are several factors pushing the industry to higher performance levels. In recent years, many new simulation requirements have been imposed as a result of the increasing capabilities of the radar system being simulated. Other requirements are driven by increasing sophistication of the EW systems being tested. Another contributing factor is the need to do more testing with smaller budgets. Fortunately, advances in the state of threat for both

digital processing and RF signal generation is advancing rapidly enough to allow threat simulator manufacturers to keep pace with ever increasing requirements.

3.1. Threat Radar Developments

In general, a great deal of work has been done to keep pace with the increasing capabilities of threat radar systems. Recently, there has been much interest in correctly simulating the latest multifunction radars. These types of radars typically use electronically scanned arrays which allow pulse-to-pulse beam pointing changes for the tracking of multiple targets while searching for new ones. Each beam position can have complex PRI patterns or pulse bursts and the changing PRI waveform must be synchronized to each beam position. Other modern radars use complex pulse coding, non linear FM, or phase coding to enhance detection and tracking capabilities. These requirements are currently being addressed and high fidelity simulations of these characteristics are readily available.

3.2. System Under Test Developments

There are many areas where recent developments in the capabilities of the EW systems under test are creating new or more stringent requirements for threat radar simulation. As the EW systems increase their measurement and processing capabilities, there are corresponding increases in requirements for threat simulation.

3.2.1. Increased Receiver Sensitivity

Receiver technology advances have resulted in increased receiver sensitivity for the systems under test. To provide a suitable test environment, a threat radar simulator must maximize the dynamic range of the RF output. The noise floor of the RF subsystem is dictated primarily by the noise floor and dynamic range of the RF source. Digitally Tuned Oscillators (DTOs) typically have lower noise floors and greater dynamic range than synthesizers. Manufacturers of both types of signal sources have recently reduced the noise floors of their sources. There have also been reductions in the phase noise, which new receivers are more sensitive to.

The RF chain used to modulate the generated waveform for transmit scan, range loss, and receiver antenna pattern must balance the distribution of component losses and amplifier gains to preserve as much of the original dynamic range as possible. The utilization of integrated RF components, consisting of amplitude or phase modulators, switched filters, and amplifiers allows the distribution of the gain to be optimized. After the dynamic range of the signal has been maximized, it must be properly positioned by tuning the maximum output power level. In the past, the emphasis was on providing maximum output power. Recently, there has been more emphasis on lowering the noise floor, at the expense of a reduction in maximum output power. As receiver sensitivity increases and the measurement capabilities of the receiver improve, EW systems are being tasked to perform additional functions where the lower noise floor is of greater importance than higher output power. (In some cases, special EW simulator test configurations are used to perform high power saturation of receiver front ends.)

Increased receiver sensitivity also results in higher emitter/pulse density requirements. The lower sensitivity allows the receiver to detect emitters at greater ranges, bringing more signals into the field of view. In addition, more sidelobe and backlobe pulses will be detected. This requires more emitter pulse generation capability in the digital generation subsystem. Distant emitters must be fully simulated to maintain coherency, even though there may only be a limited number of pulses from the main beam which are above threshold. Increased pulse density also requires more channels in the RF generation subsystem.

3.2.2. Sophisticated DF Systems

Major improvements are being made in the DF measurement techniques and capabilities of modern EW systems. Several simulation enhancements are required to provide adequate testing of these new capabilities.

3.2.2.1. Improved Motion Models

The geometry updates for platform motion increase as EW receivers measure angle of arrival to greater accuracy. In order to avoid having an emitter jump more than one angle cell between motion updates, geometry calculations must be performed at higher rates. In some cases, motion and angle of arrival modulation must be updated at rates as fast as 1000 Hz. In addition, a full 6 degrees of freedom is required to provide a proper angle simulation as an aircraft performs highly dynamic maneuvers. Testing the ability of an EW system to maintain emitter tracks during such maneuvers requires highly accurate motion models.

3.2.2.2. Doppler Modeling

Some newer EW systems utilize Doppler effects to measure angle of arrival through the use of sophisticated processing algorithms. To support testing of this capability, it is necessary to simulate both PRI and RF shifts due to the relative motion of the emitter and system under test platforms. The range delay time changes as the distance between the two platforms changes, inducing small variations in the PRI from pulse to pulse. Simulation of this effect, known as PRI Doppler, requires extremely precise pulse timing in the nanosecond range. The closure rate between the two platforms also generates frequency Doppler. Very high precision RF sources are needed to simulate these pulse to pulse variations in frequency.

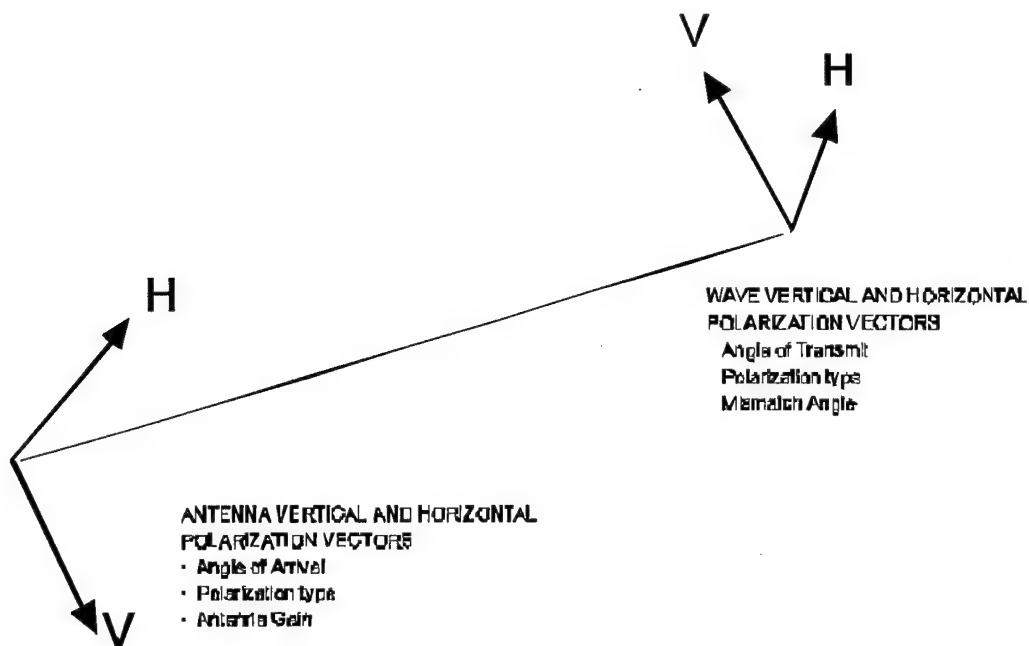
3.2.2.3. Simultaneous Phase and Amplitude

Some new receiver systems are making use of simultaneous measurements of relative phase and amplitude at several apertures to compute angle of arrival. Testing this capability requires both phase and amplitude modulation components in the RF path for each receiver port. In addition to the algorithms required to compute both phase and amplitude simultaneously, it is also necessary to account for the incidental phase shift of the attenuator and the incidental amplitude variation of the phase shifter or vector modulator. In systems which require only phase or amplitude control, the incidental effects are not significant. However, when both characteristics must be controlled in the same RF path, these effects become extremely important, especially in light of tighter accuracies needed for compatibility with current receiver capabilities. Compensation for these effects requires sophisticated multi-step calibration algorithms.

In addition, new receivers are using increased numbers of apertures to provide more precise angle measurements and to allow multiple functions, such as signal detection and precision direction finding, to be performed simultaneously. To support this, a more modular architecture which provides more parallel processing is required. For a receiver with dozens of apertures, it is impractical to compute all of the required phase and amplitude values at a central point. An added benefit of a more distributed architecture is that the design is more easily scaled to a specific system under test configuration.

3.2.2.4. Polarization Modeling

Some new EW systems are making use of apertures with both vertical and horizontal polarization, rather than circular polarization. Complex aperture modeling is required to properly stimulate each aperture. For each emitter, the polarization orientation of the transmitted waveform must be matched against the vertical and horizontal response of each receive aperture. Figure 1 shows the transmitted wave vectors and receive aperture vectors and how they are combined mathematically.



ELEMENT RESPONSE TO WAVE IS $(V_{\text{ELEMENT}} \times V_{\text{WAVE}}) + (H_{\text{ELEMENT}} \times H_{\text{WAVE}})$

DATA-064-06-199

Figure 1

The pulse to pulse orientation of both the transmit and receive platforms must be accounted for in the calculation of the relative orientation of the transmitted waveform at the receive aperture. Figure 2 illustrates how the orientation of the wave relative to the receive aperture is determined.

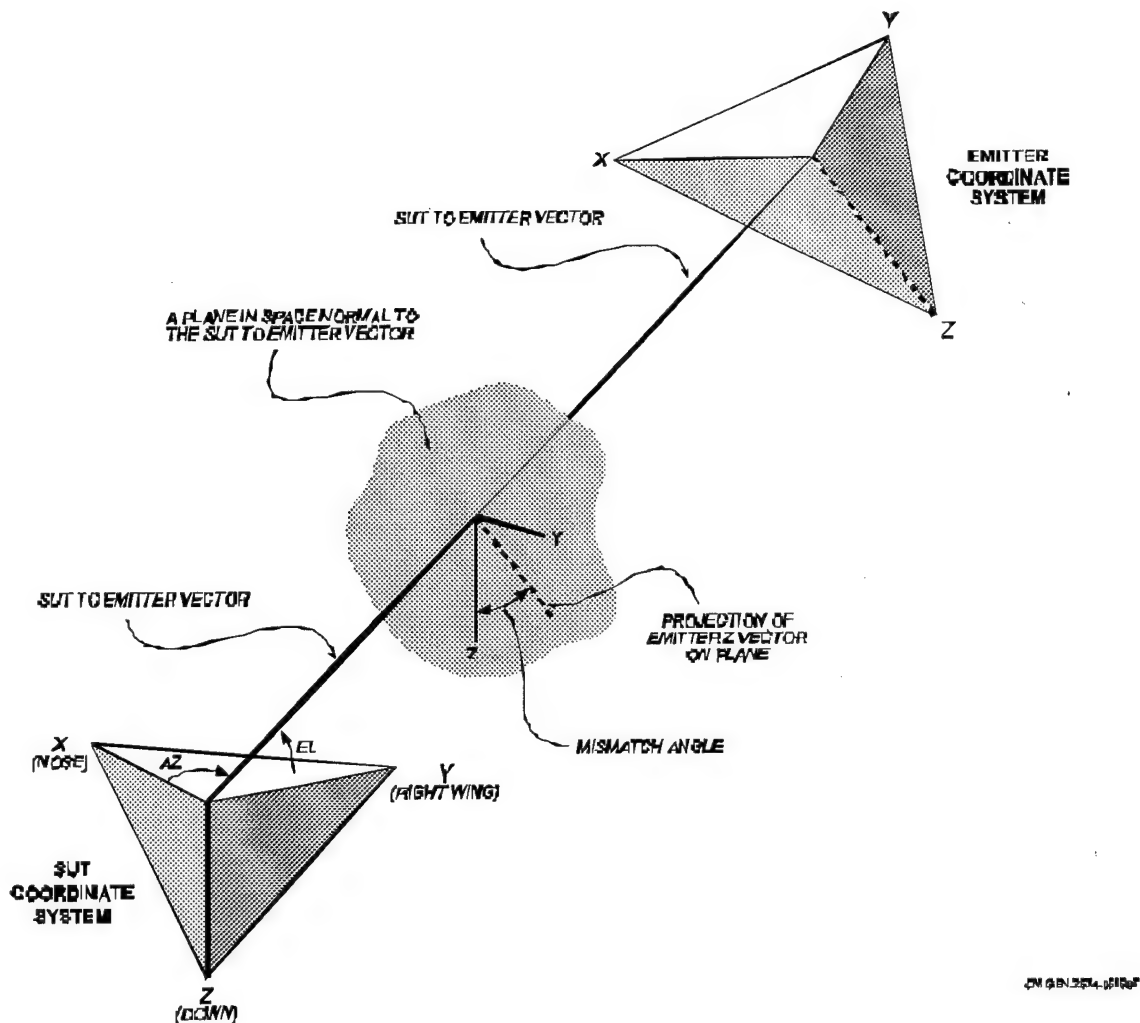


Figure 2

In some cases, measured data shows that transmit polarization varies significantly outside the main beam and this must also be accounted for through the use of a full three dimensional polarization model.

3.2.2.5. Time Difference of Arrival

Another emerging technology is the use of time difference of arrival for direction finding. This requires precise pulse timing control for each receiver aperture. Typically, timing is required to one (1) ns resolution, with a maximum variance from port to port of 150-200 nsec. For normal angle of arrival simulation, the generated pulse is split into several paths, one for each receiver aperture, and then phase or amplitude modulated as a function of the geometry. In this case, the leading edge of the pulse is delayed, leading to corruption of any intrapulse characteristics of the generated pulse. An analysis of the most common intrapulse modulations leads to the conclusion that preservation of bi/quadphase modulation is desirable, and can be included at an acceptable cost. The timing delay from one receiver aperture to another may be large enough that an entire phase modulation bin would be eliminated from the pulse. Systems looking for specific modulation pattern content would detect different patterns at different ports. On the other hand, typical chirp and FMOP modulations are such that elimination of a small portion of the leading edge of the modulation is not significant to the receiver. The same is true of most AMOP

modulations. Of course, the technology to preserve all intrapulse characteristics is available, but at significant cost. For most systems, inclusion of separate frequency and amplitude intrapulse modulation elements for each receiver aperture is not required. Where pulse rise and fall times are controlled for each emitter, this characteristic must be preserved for each receive aperture.

3.2.3. Receiver/Processor Capability

As with many things, the processing capability of EW systems is increasing dramatically. As a result, modern EW systems have increased track file size and are expected to handle environments with higher emitter/pulse densities. Threat radar simulators must be able to provide these additional densities to stress the processing capabilities of these new receiver processor systems. Another application of the increased processing capability is the utilization of precisely measured pulse times in sophisticated algorithms to identify the underlying clock characteristics of a specific radar. In support of this, threat simulators must be able to model crystal count-down techniques for PRI generation with extreme precision and must be able to control pulse start times to one (1) ns or less.

3.2.4. Integrated EW Suites

As EW suites become more integrated, it is necessary to provide threat simulators capable of stimulating apertures for multiple receivers simultaneously. Separate outputs may be required for an RWR, a jammer, and an ESM system. While no one system may have a large number of apertures, taken together, an integrated suite can easily have upwards of 40 apertures. Also, the different systems may use different direction finding techniques, including amplitude, phase, time difference of arrival, or a spinning antenna. The threat simulator must be capable of modeling each different direction finding technique simultaneously for each pulse. A distributed processing architecture again becomes critical to supporting this requirement. In addition, the various subsystems of an integrated suite quite typically communicate with each other over a standard bus. To support development and testing of individual subsystems, it may be necessary for the threat simulator to provide a simulation of bus message traffic. For example, testing a jammer may require generation of message traffic normally provided by the radar warning receiver.

3.2.5. Sensor Fusion

Sensor fusion is a growing element of modern electronic warfare. With Sensor Fusion, there may be several sensors, including a communications receiver, radar, EW receiver, and an IR sensor, which all detect and characterize various target signatures. Higher level software attempts to correlate detections from each sensor in order to increase confidence in target identification and location. A true multispectral stimulus is required to support testing of the fusion algorithms. A coordinated environment, including precise time and motion synchronization must be presented to each sensor. Each player must appear at same time for each sensor, and each sensor must see the player at the same location. There may also be a need for informational synchronization, where signatures with message content accurately represent the environment being simulated. This requires the ability to program a common scenario for all of the stimulators, and each stimulator must be capable of accepting precise time synchronization from a master control during a real time simulation.

3.3. Multipurpose Laboratories

As laboratories are consolidated, there is a growing need for a single laboratory to support multiple systems under test. It is no longer cost effective to have simulator systems configured to support a single receiver configuration. The simulator must provide reconfigurable test assets which can be rapidly reprogrammed to provide phase, amplitude, or time difference of arrival modulation for each output port. In addition, it is desirable to have a flexible architecture where the interconnection of RF generators and angle of arrival modulation assets can be changed to provide a higher channel density with fewer output ports, or higher number of output ports for a

reduced number of channels. This allows a laboratory to be readily configured to meet changing test requirements and receiver configurations.

3.4. Training Applications

Training applications for EW threat simulators are expanding rapidly. There is growing interest in stimulating real avionics rather than modeling the function of the avionics in a trainer. This is true for both on board trainers for ships and classroom trainers. Software models of an EW system require extensive validation and constant updates as the EW system is improved. The use of actual EW system hardware eliminates the validation step, and provides a more realistic training environment. It is not always necessary to stress the processing capabilities of an EW system for a training application, creating a need for smaller simulator configurations which still provide full emitter fidelity. This is especially true for on board trainer systems. Also, digital injection can provide a more cost effective means to utilize actual avionics as part of a trainer. This requires a digital model of the receiver front end, but eliminates the need for expensive RF generation subsystems and also eliminates the need to have the actual system under test receivers present. Distributed training applications also require threat simulators which can support real time control interfaces using Distributed Interactive Simulation (DIS) or High Level Architecture (HLA) protocols.

3.5. Shrinking Flight Test Budgets

Flight test budgets are shrinking, placing more emphasis on laboratory simulation. To support this, there is a need for higher fidelity simulation of environmental factors such as terrain masking, multipath, ducting, weather effects, and wave splashover. All of these characteristics are present in range testing or sea trials. In order to be more reliant on laboratory testing, these environmental effects must be accurately modeled. This provides higher correlation between laboratory results and flight test or sea trial results. As the correlation between the results from the two forms of testing increases, the value of laboratory testing will increase, and more aspects of system performance can be characterized and verified without costly flight testing.

3.6. Range Applications

Modern EW ranges require greater flexibility. There is a need for dual use ranges, which can support both test & evaluation and training requirements. For training applications, it is desirable to have a training range integrated with an EW simulation. For these applications, an EW threat simulator can be used to model the transmit characteristics of a threat radar. A measurement receiver can be used to detect jamming signals from the aircraft being illuminated to support model based reactive emitter control. A major benefit of adapting an EW threat simulator for range use is rapid reprogrammability, where a single threat site can be used to simulate multiple radar sites during a single training exercise or test. To maximize the flexibility of each threat site, wider band transmitters are used, with some tradeoff in output power. This also provides the capability to simulate multiple emitters from a single site, providing a cost effective increase in signal density.

3.7. Support Tools Software Environment Generator

As the capabilities of threat simulators have grown and environment densities have increased, there has been a higher demand for enhanced support tools. A major emerging requirement is the need for automatic dynamic scenario generation. These scenario generation tools allow the user to specify an initial threat laydown and rules of engagement which are then processed by an engagement model. The model may use either a predefined flight path for the system under test platform or it may allow a man in the loop to fly the system under test. As the system under test platform moves through the environment, the engagement model controls emitter activity according to the previously specified rules of engagement. The engagement model facilitates generation of realistic dynamic scenarios and allows multiple flight paths to be analyzed for scenario density and EW system performance.

In the interest of maximizing the utilization of simulator assets, there is a growing need for non-real time signal generation and analysis tools. These tools allow the operator to use a software model to generate a pulse by pulse representation of a scenario and save the results in a disk file. This can be done on a stand alone workstation without tying up the simulator hardware assets. Once the pulse file is created, analysis tools can provide RF signal characterization, density computation and graphical plots of pulse trains which can be used for emitter programming verification. In addition, pulse density analysis tools can be used to predict system throughput, pulse contention and dropout. These predictions can be used in RF configuration and scenario tuning to optimize simulator performance. Figure 3 shows an example of one of the several analysis tools available. This tool calculates a scenario emitter or pulse density as a function of time, frequency, AOA, amplitude or several other user-specified parameters

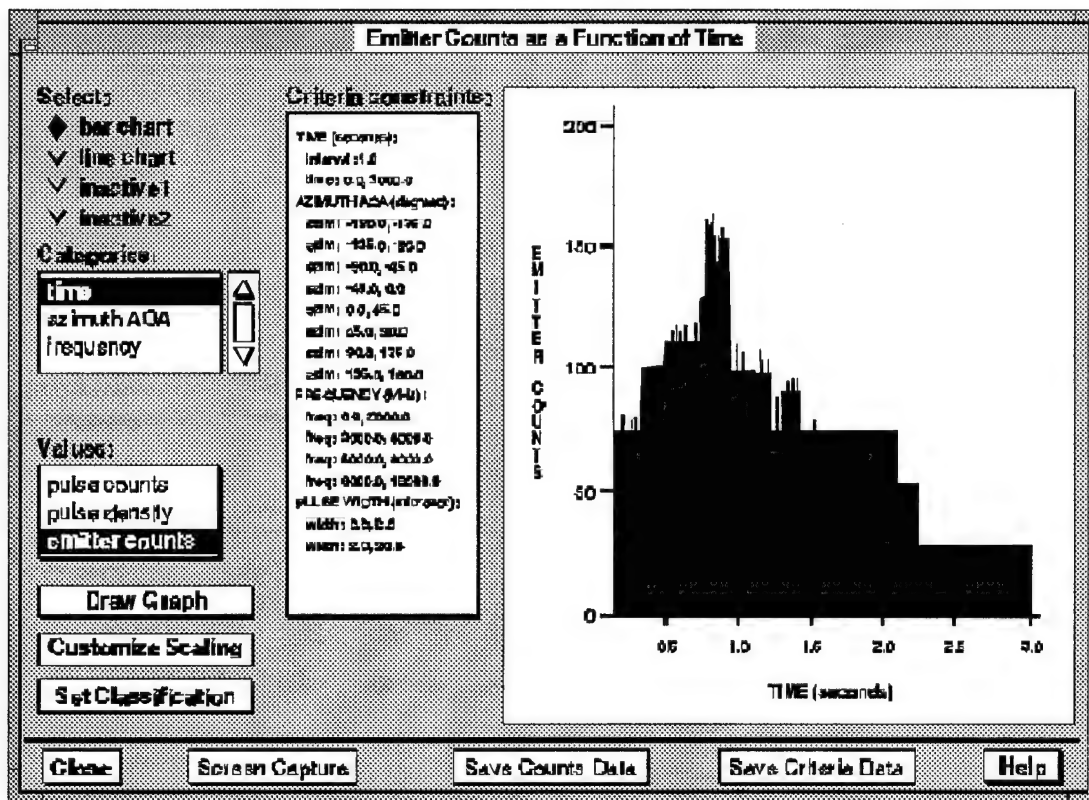


Figure 3

3.8. Integrated Simulator Applications

As laboratory simulations become more sophisticated, there is a need for real time interfaces for laboratory integration. These interfaces may include ownship navigation control, platform control and emitter control. The host processor may be running a higher level SUT simulation or utilizing real time engagement or performance models to generate real time scenario changes. Real time interfaces may also be used to support a man in the loop flight simulator. These types of applications require the threat simulator to react to external inputs in order to provide a truly reactive environment. Other applications require remote scenario monitoring by a host computer. Trainer systems may utilize a real time interface to the instructor station to support real time changes to the training exercise and monitoring of student performance.

3.9. Monitoring and Analysis

There is growing interest in monitoring and analysis tools to aid users in the verification of simulations and analysis of system performance.

3.9.1. Signal Generation Verification

In any test situation, there is a need for "truth" data, a record of the actual test stimulus that was generated. This is needed to verify that the correct emitter waveforms were generated and to monitor simulator performance. Truth data may be recorded in the form of digital pulse descriptor words which can be post processed for performance analysis. This form of data is useful for detailed analysis of pulse train generation and simulator throughput. Another form of truth data is generated by a real time signal measurement system. This system captures, analyzes, and records the actual RF output of the threat simulator. This provides verification of signal generation at the final outputs of the simulator for maximum confidence.

3.9.2. SUT Performance Analysis

When a system under test is subjected to a dense dynamic scenario stimulus, it is not feasible to determine EW system performance manually. There is a need for analysis tools which can automatically correlate the generated stimulus to the characterization of the environment made by the system under test. Truth data recorded by the threat simulator provides one input to the correlation process. The other input can be provided by re-recording emitter reports or similar data available on standard busses within the system under test. Additional data may be in the form of real time measurement of actual ECM outputs generated by a jammer system. The simulator truth data and recorded system under test data are correlated to determine correctly identified emitters, time to detection, accuracy of measured parameters such as frequency or angle of arrival, missed emitters, and false emitter reports. These results can be analyzed statistically or presented in graphical form to determine quantitative performance of the system under test.

4. Summary

EW threat simulation capabilities must meet ever expanding requirements. These requirements are the result of the increasing capabilities of threat radars and the increasing detection and processing capabilities of EW systems. Other factors influencing emerging requirements include the need for higher fidelity simulation capability to provide closer correlation between laboratory testing and flight testing in order to allow greater reliance on laboratory results. To meet these requirements, a new generation of EW threat simulators must make use of state of the art technologies, including modular scaleable architectures, high speed DSP/RISC processors, and integrated RF subassemblies. Advanced software models are needed for scenario effects including platform motion, direction finding modulation computation, and environmental models. Significant investments by both EW threat simulator manufacturers and users are required to keep pace with these changing requirements.

Title: The Simulation Challenge within a SIL Test Environment, the EWAISF

Presenter: Mr. Jerome M. Smith

Track: SOS

Day:

Keywords: simulation, threat files, development process, testing, SIL

Abstract: This paper will focus upon the challenge of transforming intelligence and system information into adequate simulation test files within a Systems Integration Laboratory (SIL) environment. The purpose of the simulation is to facilitate development and testing of electronic warfare systems. The paper will provide a discussion of the challenge, a process of handling the challenge, the technology employed and/or is necessary, and a relationship among process, people and technology.

The Simulation Challenge within a SIL Test Environment, the EWAISF

Possessing adequate simulation is a challenge that must be met to allow reaping the benefits of new acquisition and test strategies. This challenge is not unique to System Integration Laboratories (SILs). This discussion will focus upon the simulation challenge within a SIL test environment. The simulation challenge concerns three aspects: 1) the acquisition of the necessary data or information, 2) the implementation and use of data in creating resultant simulation work products, and 3) retention and dissemination of data and simulation products.

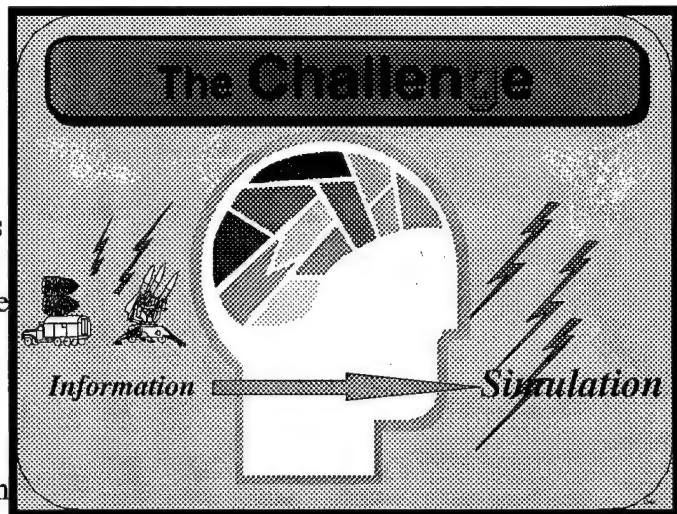
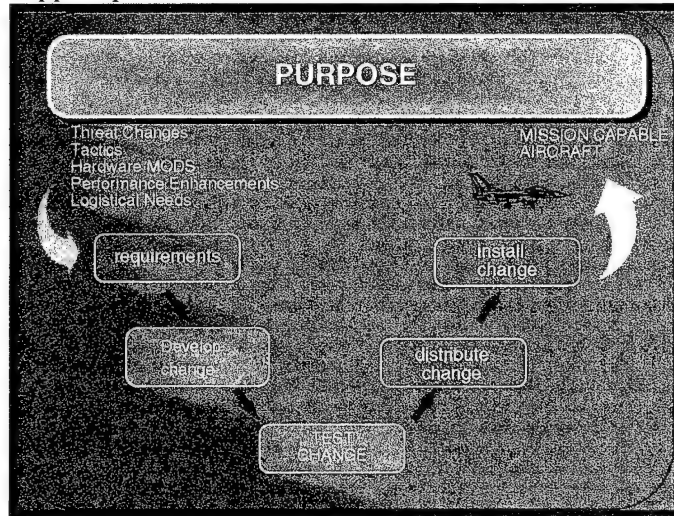


Figure 1

1.0 The EWAISF

The Electronic Warfare Avionics Integration Support Facility (EWAISF) is a government facility which serves a dual role as an Air Force commodity electronic warfare systems management

& software support center and as a system integration laboratory (SIL) for the electronic combat test community. Simulation of threat emitters or signals has always been a part of the software change development and testing process methodology. A high level overview of the electronic warfare software support process flow is as follows: As one or more external factors (such as threat changes, a change in



tactics, a change in system hardware, a need to enhance system performance, or a need to satisfy logistical requirements) occurs, the change process starts. New or updated requirements are provided to the EWAISF team. The requirements are processed within the EWAISF in order to develop the electronic warfare system software change and the required test simulation. **Threat simulation** is used in a series of informal and formal tests including code debug, mission data, integration, verification & validation and kitproofing. After the resultant change is formally released by a configuration

Figure 2

board, the change is distributed and then installed into the aircraft which allows a more mission capable posture. A typical EWAISF Integration Support Station (ISS) laboratory configuration is shown in figure 3. This configuration consists of actual electronic warfare system hardware, computer hardware and software, and simulation.

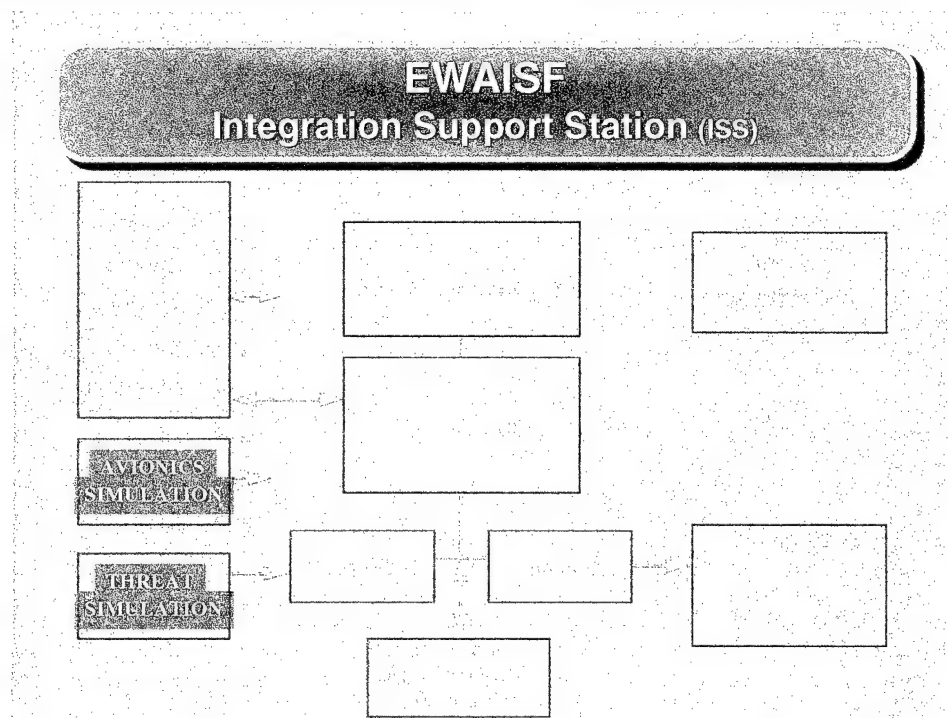


Figure 3

2.0 Our Simulation Process and Technology

The EWAISF simulation process has a goal of producing adequate threat simulation files in support of electronic warfare systems support. How we meet the simulation challenge could affect several of the Air Force's Core Competencies. The core competencies are part of the strategic vision and plans of the Air Force in the 21st Century. The core competencies are Air and Space Superiority, Global Attack, Rapid Global Mobility, Precision Engagement, Information Superiority, and Agile Combat Support. The competencies are tied to knowledge, expertise, and technological implementation that, when properly applied, produces superior military capabilities.¹ Our simulation process is dependent upon information, applied knowledge, threat expertise and software & simulation technology innovation. The basic aspects of our simulation process are 1) effective process methodologies & technological innovation, 2) expertise base, and 3) key process participants.

The *IDEAL*

If we operated in an ideal situation, the input information and data requirements would be timely received, comprehensive and technically appropriate. Our implementation or utilization phase would be characterized by perfect management, manipulation and use. The resulting product would be always providing the right quantity, exhibiting absolute technical correctness and, of course, providing perfect utility.

The *REALITY*

Our operating environment does not conform to the ideal situation. We wrestle with a complex "wicked problem". "Wicked problem" as defined by E. Jeffrey Conklin and William Weil in their paper **Wicked Problems: Naming the Pain in Organizations**, defines a wicked problem having the following attributes: 1) evolving set of interlocking issues and constraints; 2) there are many people and organizations that are affected or care about the resolution; 3) constraints are present and can change over time; and 4) difficult to definitize.² Our reality, I believe can be categorized as being "wicked". The elements of our "wicked problem" is shown in figure 4. Schedule is rarely simulation friendly; results are wanted **NOW**. The simulation must be accurate and with a high degree of fidelity. Cost, resources and technical requirements constraints can change over time. There are many players, officials, and spectators. Warfare is often difficult to thoroughly definitize and bound the tasking. The necessary inputs can include technical, program, and strategy elements. Data

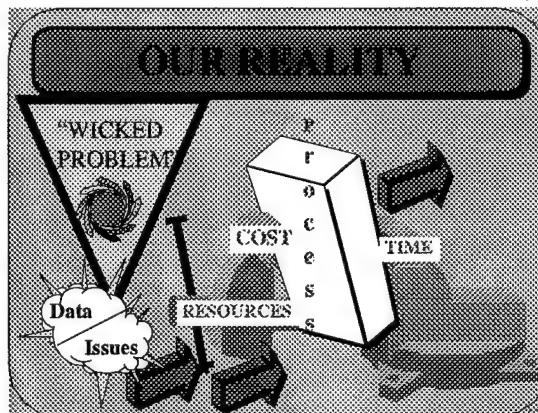


Figure 4

¹ Global Engagement: A Vision for the 21st Century, Core Competencies—<http://www.xp.hq.af.mil/xpx/21/core.htm>.

² Wicked Problems: Naming the Pain in Organizations, E. Jeffrey Conklin & William Weil—<http://www.gdss.com/wicked.htm>

complexity can range from simple bits to aggregate volumes. The data may be random or organized. We concentrate upon the engineering model level of the simulation spectrum. We are most active in the production, fielding/deployment and operational support phases of the acquisition lifecycle. Our process consists of three subprocesses: 1) the definition phase, 2) the implementation phase, and 3) the application phase.

The Definition Phase

In the definition phase, we accomplish the design of the simulation. Arriving at a technical visualization, as pictured in figure 5, is dependent upon several factors. At the programmatic level, there is the dissection of the requirements to provide an estimate of the simulation effort in respect to time, cost and performance constraints. Technically, the simulations to be designed are dependent upon 1) operational characteristic and compositional data and 2) simulator platform parametric mapping. Our data concerns include accuracy and currency of the information. Also, the data must be understandable and reasonably presented, identified, and properly correlated with associated data. Simulator platform parametric mapping involves determination of complexity, trade-off options, fidelity requirements, and other requirements and constraints reconciliation. We do not operate in

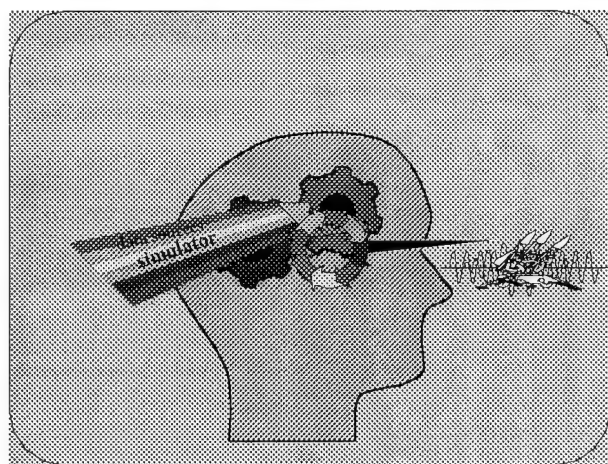


Figure 5

an "one size fits all" environment. The EW system platform, the system under test, or the test objective can also tailor the simulation design. In our environment, there are many simulation components. These include specific signal characteristics that are platform, system, or subsystem related as shown in figure 6. The required simulation may be a single beam of an One-on-One situation, multiple single beams of different emitters, multiple beams of one or more emitters, or a Many-on-One situation. The situation could be a static test case or a time scenario involving events and/or spatial movement. The test case may require that other signals other than EW signals be present. Our basic building block is the **MODE**. Systems to be simulated can have seemingly infinite operational modes. It is not possible given our operating constraints to deal with all instances. We select our simulation candidates upon the following considerations (figure 7): 1) our customer's (user) information such as mission, role, and expected operational environment of the EW system(s); 2) system information such as threat reaction and

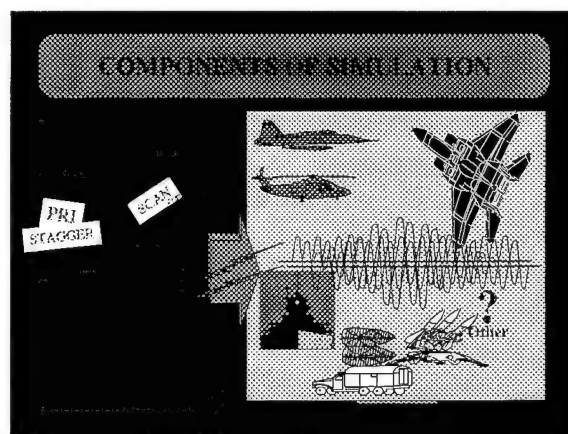
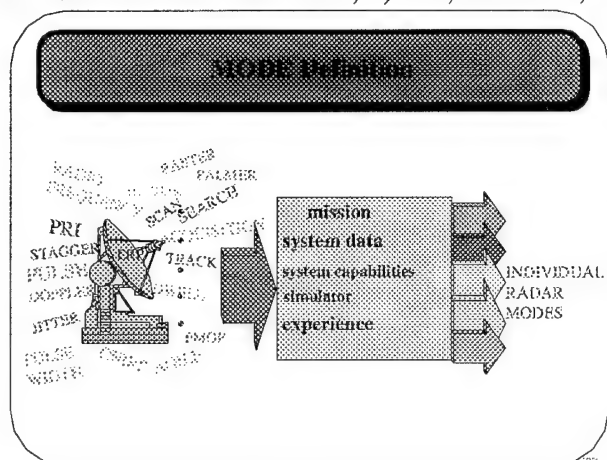


Figure 6

operating characteristics; 3) EW system information such as spectrum coverage, receiver & processing implementation, mission programming, and display options; 4) the strengths and limitations of our simulators; 5) and, of course, inherent educated and experienced mental



activity. The threat data, the various parameters or signal characteristics, of a particular simulation candidate are defined and developed into a threat definition which will result in a simulator file in the implementation phase. The parameters are properly assigned to create the individual mode. Our mode (simulation definition) may be different from another mode in only one critical parametric. Some modes are related to others and we maintain that relationship through the definition and the implementation of the simulation. A summary of our

definition phase is as follows: 1) characterized by data acquisition and manipulation; 2) is dependent upon logic and visualization, presently largely a human tasking; and 3) needs automation further than the employed database technology.

The Implementation Phase

Departure from the definition phase means that we are confident of knowing the requirements adequately; of the simulation design to produce adequate modes; and of our simulator(s) to accept the definition. The purpose of the implementation phase is to translate the definition from a design to a simulation file capable of being used. Figure 8 shows our technology attempt to assist the simulation definition and implementation phase by automation.

**PC workstation
software procedures
networked to simulator
controller to simulator
RF subsystem.**

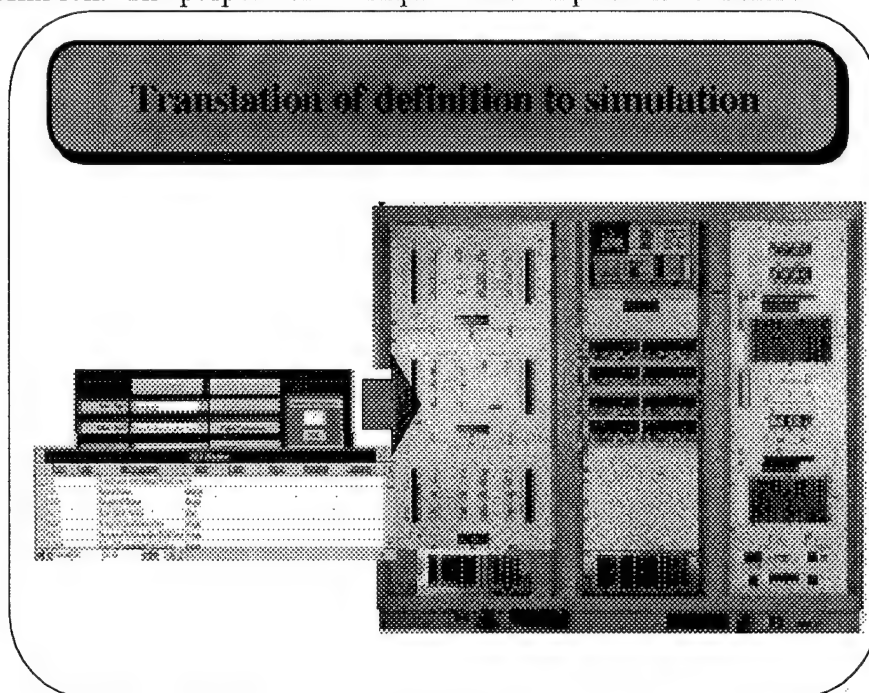


FIGURE 8

Our implementation process consists of three subprocess steps and one major decision step. The first step is called **parametric entry**. A simulation definition can be quite complex and require a large number of entries of data and data sets. Currently, we employ both manual and "automated" means of populating the simulator's file formats. This step requires a high degree of accuracy and associated data manipulation skill. Communication between the simulation designer and the simulator implementer is necessary. The second step consists of two parts, **execute and measure**, begins after the simulator is populated with the simulation definition. We execute in real-time the simulator file and measure the critical parameters. In this step, we find out if the definition is acceptable to the simulator. This part involves the simulator technician (implementer), the simulator, the definition, test equipment. The second part, **analyze**, follows or is performed concurrent with the execute and measure action. This action involves processing data to assist in answering the questions whether the simulator file is accurate, whether the file operates correctly, and whether any outstanding or unexpected limitations were found. Communication between the simulation designer and the simulator implementer is important. The third step, **evaluate**, is the action which answers the questions and determines the next action to take. The choices include: 1) is an adjustment needed to the simulation, 2) does the simulator's software or hardware need attention, or 3) the simulation meets criteria. The decision step, **accept**, involves: 1) simulation is available for testing use and 2) simulation becomes an item for our threat library procedure. Our library procedure requires constant information source awareness and continued partnerships. As part of our library procedure, the simulation files are reviewed and kept current. Feedback from testing use is also important. A pictorial of the implementation process is below in figure 9.

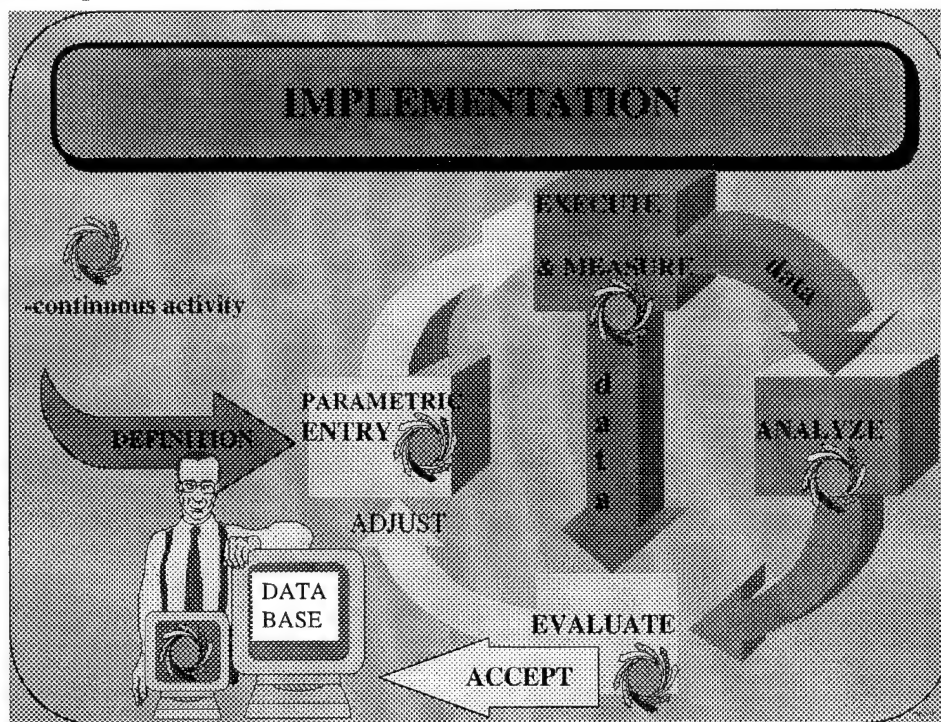


Figure 9

The Application Phase

Before discussing the application phase, some more background information about the EWAISF, test operations, and simulator database will assist. The simulation and evaluation branch supports a number of EW systems. Any or all may need critical simulation support. We operate in what can be described as "prime time" and in an environment in which demands expert performance. In the EWAISF, there are a number of threat simulators (over 25) mainly in the radio frequency (RF) spectrum. In support of the EW systems, we have over 4,000 simulation files replicating modes of about 510 threats. In addition, we support these EW systems with other required test stimuli. Figure 10 gives a pictorial view of the EWAISF in block diagram form with our networking and key elements.

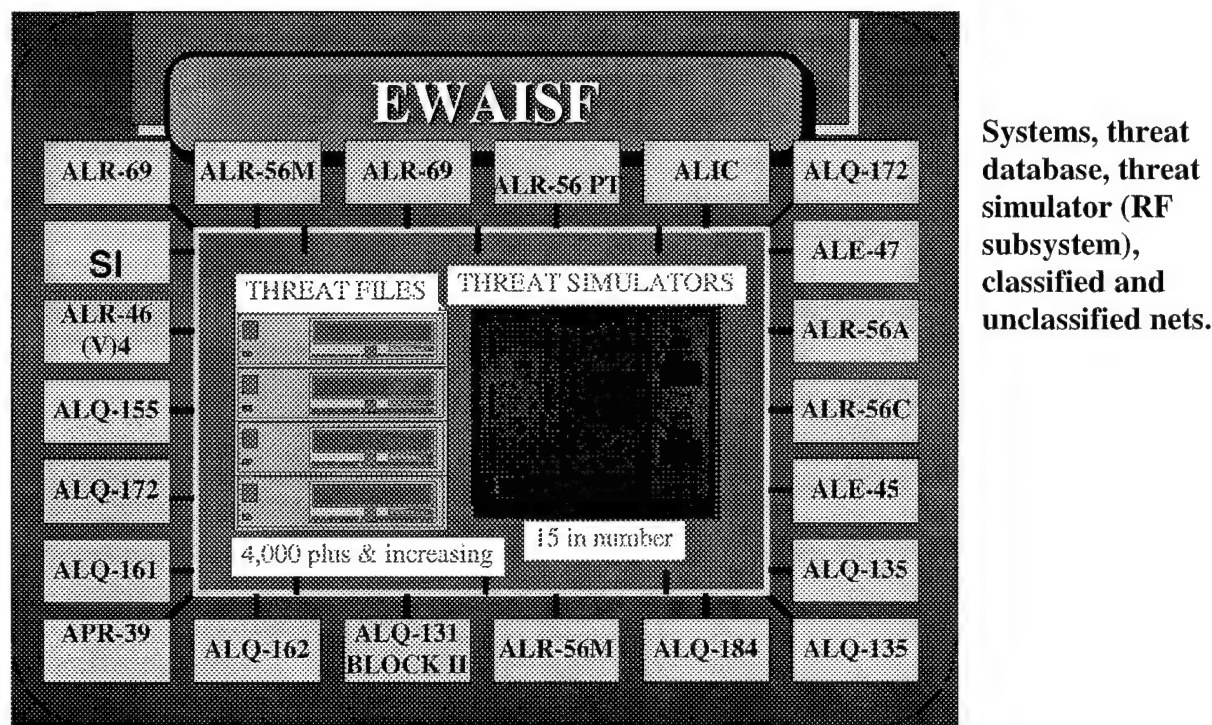


Figure 10

The basic building block for the EWAISF is the Integrated Support Station (ISS). ISSs exist within the EWAISF to support software change development, test, and other system support activities. The heart of each ISS is the EW system which is implemented as hardware, simulated or hybrid entities. Simulation capability, especially threat simulations, is an important component of each ISS and our test methodology. Figure 11 shows in block diagram form the composition of an EWAISF ISS. Brief description of each component is as follows: 1) The EW UUT -- the component which includes the hardware, firmware and software of the EW system (unit under test). In our implementation, not all EW system components are necessary. 2) The EW UUT Control -- this component may be the EW system's own processor(s) or a separate computer which allows controlling system functioning. 3) The EW UUT Monitor -- this

component is specialized and general test equipment which provide instrumented data collection and analysis capability. 4) Simulator -- component which provides the Radio Frequency (RF) threat environment. We also have one IR threat simulator. Our current threat library is mostly in the RF spectrum. 5) Avionics Simulation -- this component provides other signals such as navigational data. 6) Test Control -- The function of this component is to provide some level of automated test sequencing and scoring of EW system performance. The concept is in the third phase of implementation in the EWAISF. 7) Simulation Design Assistant -- This component is to provide some design and implementation assistance for threat simulations. In this effort, we have completed a concept demonstration. 8) Process Monitoring & Control -- This component is to allow enhanced event correlation and time synchronization and to provide RF threat simulation status and parameter monitoring. Automation of this component is being pursued. 9) Timing Reference -- Component to establish basic timing synchronization between the ISS components. 10) Computer networking, databus, and RF cabling -- this component provides for both classified and unclassified information transfer. This figure (figure 11) is related to figure 3

in that figure 3 shows a view of the EW UUT.

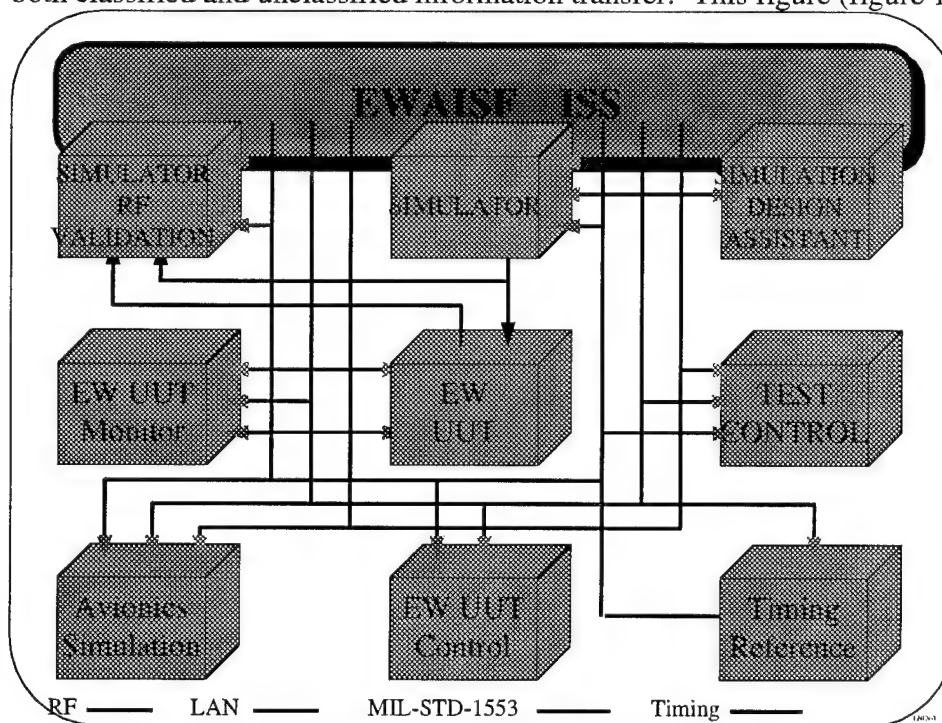


Figure 11

Application Issues

In our test methodology, the focus is whether the simulation files are suitable to provide the stimuli in order to test the EW systems. In preparing for an EW system test, our first question to be answered is does a simulation file exist? If not, we initiate the definition phase. The next question is how dated and accurate is the simulation? We must operate with the latest and with highest possible accuracy. The third question is there any "side effects" due to simulation tailoring? We are concerned with proper scoring of EW system performance due to any testing limitation. Lastly, we are concerned with proper testing execution. Is the simulator

operating within the design tolerances of the simulation file and of the simulator's hardware and software? Figure 12 is a pictorial overview of the application phase. The inputs are 1) a programmed simulator, 2) engineering documentation of the simulation, and 3) test documentation (plan, procedure, and predicted results (for automated scoring)). This phase utilizes execution of simulation test files and evaluation of system response data. There is much communication and interaction among the test engineer, the simulation implementer (simulator technician), the simulation designer, the EW system engineer, and, often, the customer. We are striving for a level of automation in the execution of our testing; however, there is still much value for maintaining the human test factor.

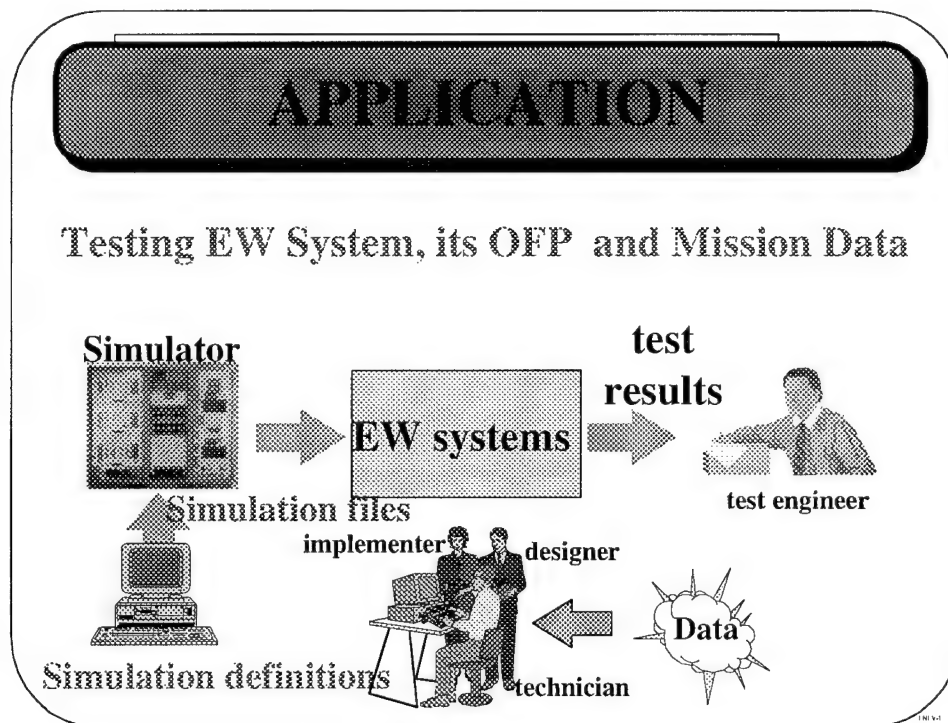


Figure 12

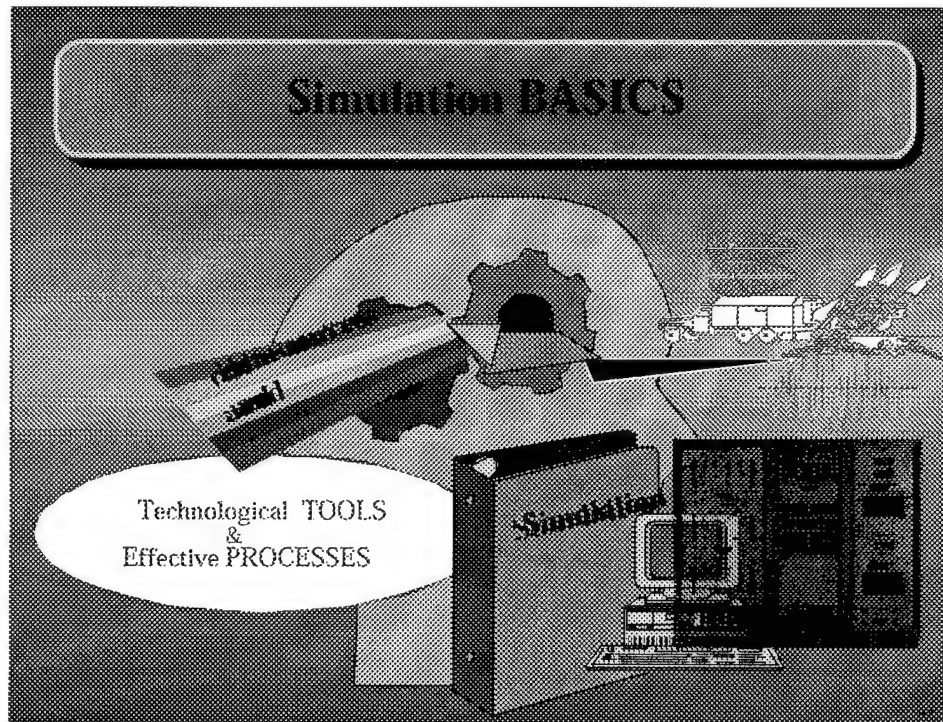
3.0 Keys to *SUCCESS*

Developing and using simulation files successfully depends upon three distinct items:
effective processes & technological tools,
skilled personnel,
and active intelligent partnerships.

The three components do not have to be equal but there is a proper **balance**.

Unbalance in any area creates difficulties and constraints and intensifies the simulation challenge.

The three components are necessary simulation basics.



Effective Processes & Technological Tools

Without an effective process and the technological tools to accomplish the process steps, data acquisition and manipulation, simulation definition and design, and simulation implementation would be a very formidable tasking.

Figure 13

The cycle consists of these steps: development, execution, analysis & evaluation and improvement. The process must be flexible enough to allow for creative innovation and to assimilate technology as tools are developed and are available.

Skilled Personnel

The second factor in our simulation equation is personnel. The discussion will focus upon the knowledge and skill requirements. The process of designing, building, and using threat simulations is a busy and highly involved set of operations. Due to the number of variables and the differences between threats, design solutions are almost infinite.

Currently no complete training course and no complete user's guide exist.

Some of the types of knowledge and skill required are presented in the following figures. Basic understanding of RADAR principles is fundamental. Knowledge of test instruments, of their application and use, and of complex measurement principles is required. Understanding signal acquisition and processing functions of the EW system under test is important. As EW systems evolve into integrated suites, one must understand the total system architecture, the system and subsystem functional capabilities, and points to acquire adequate test data.

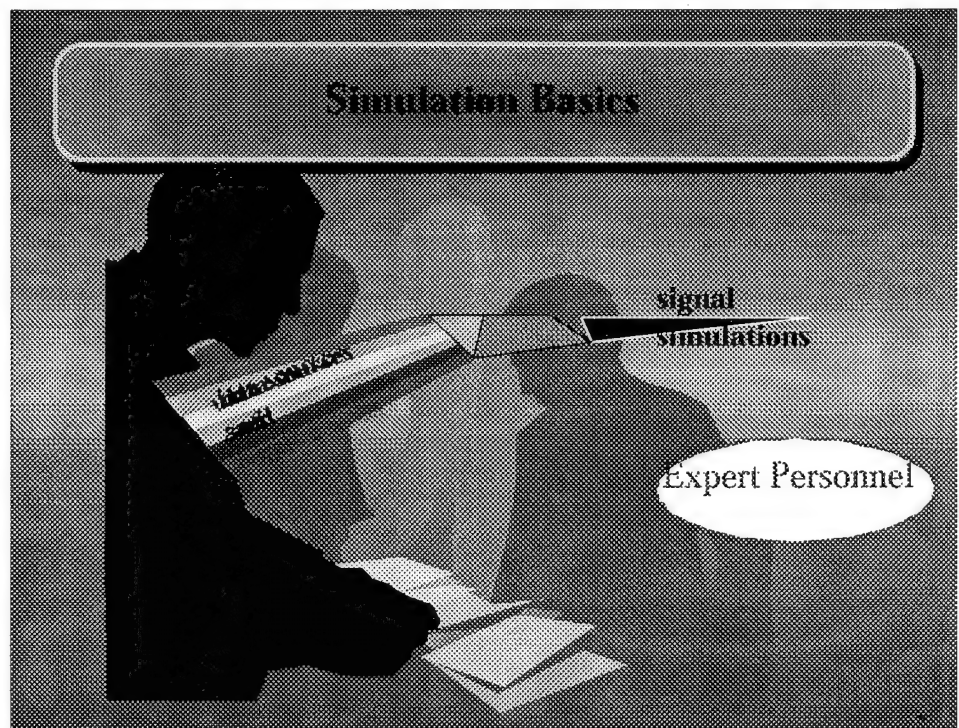


Figure 14

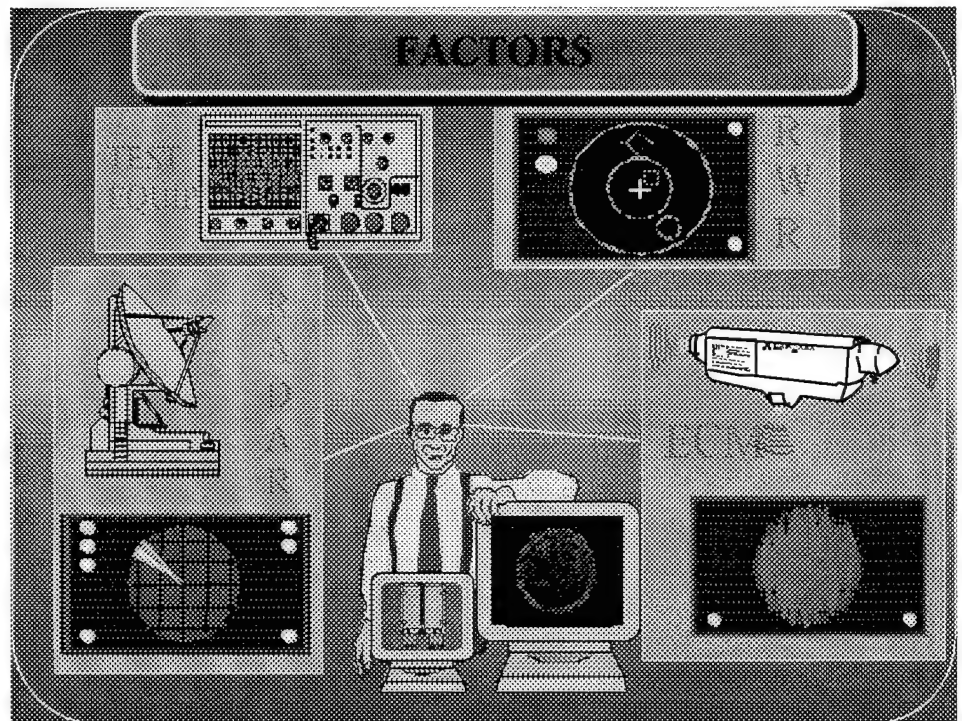
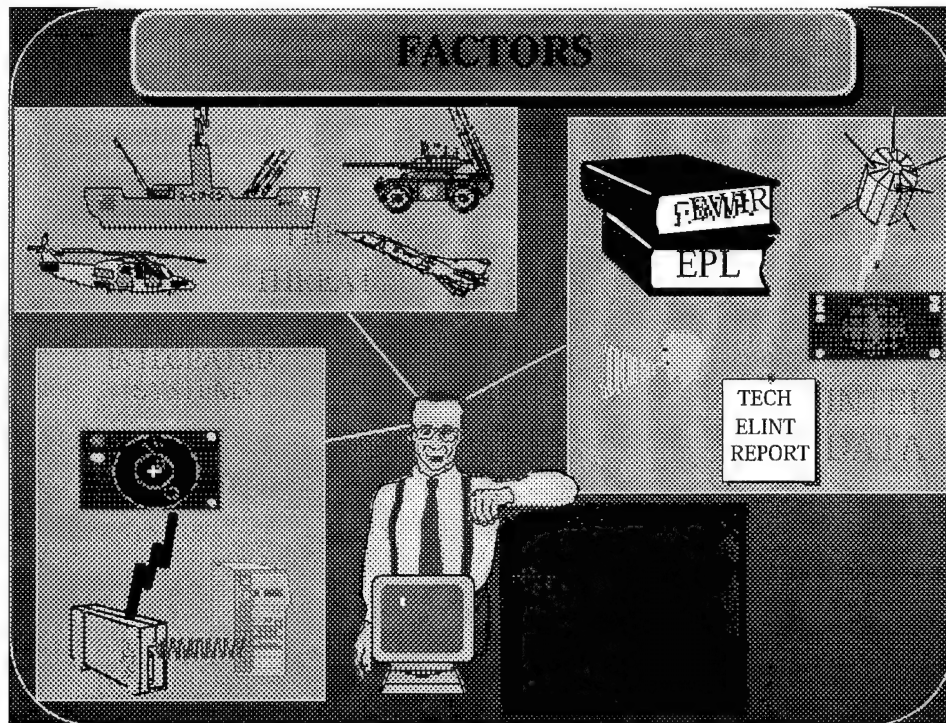


Figure 15



The most critical aspect is to keep current about the threats of interest. Knowledge of threat information databases, their formats, and embedded technical data is necessary in keeping current. Simulation theory and application practice, simulator platform acquisition & sustainment, and simulation software are also very

important. The necessary knowledge and skill in our circumstance is distributed among a small team. Similar to the overall success keys, there must be proper balance. Technology can provide assistance in performing simulation operations and in training of personnel but the required technological toolset are not available.

Partnerships

Intelligent partnerships are important. Our partnerships include the following: 1) our **customers** -- the providers of the requirements and of the necessary funding; 2) our **intelligence sources** - the providers of the necessary threat data; 3)

our **logistics and research partners** who provide hardware, software and facilities; 4) our **test**

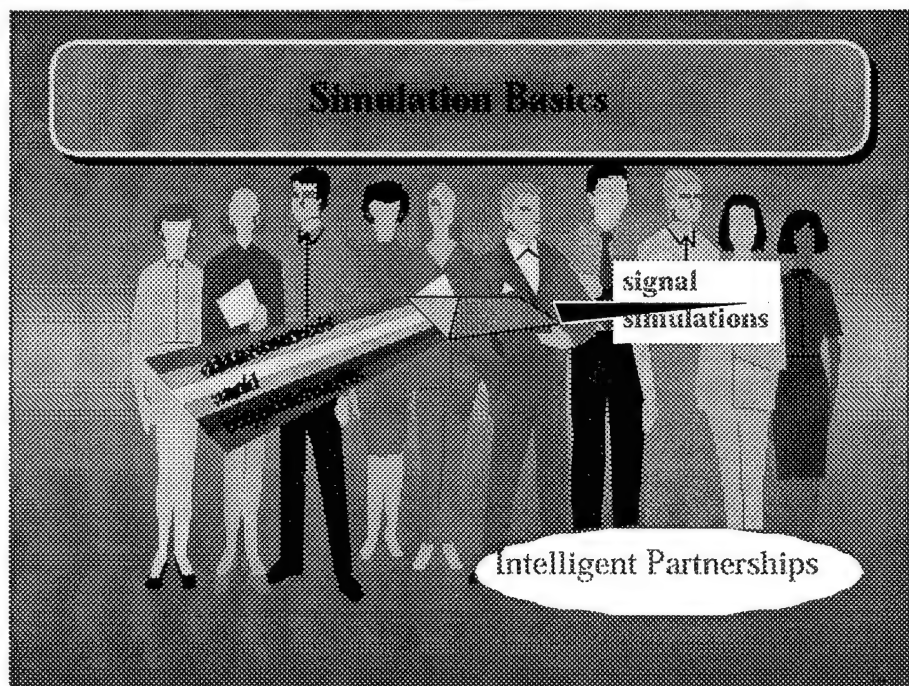


Figure 17

partners who provide test data and test methodology practices; and 5) our **contractors** who provide technical and materiel support.

4.0 Conclusion

Today there is a challenge within a System Integration Laboratory concerning adequate development and use of simulations. Meeting tomorrow's simulation challenge will still depend upon these three basic resources in proper balance: 1) expert personnel; 2) intelligent partnerships; and 3) technology and processes. The process and technology are certainly very critical in maintaining excellence; however, we must not fail to realize that although personnel elimination is good for the financial aspect of operations, that the performance edge has come from human effort and expertise.

Acknowledgments

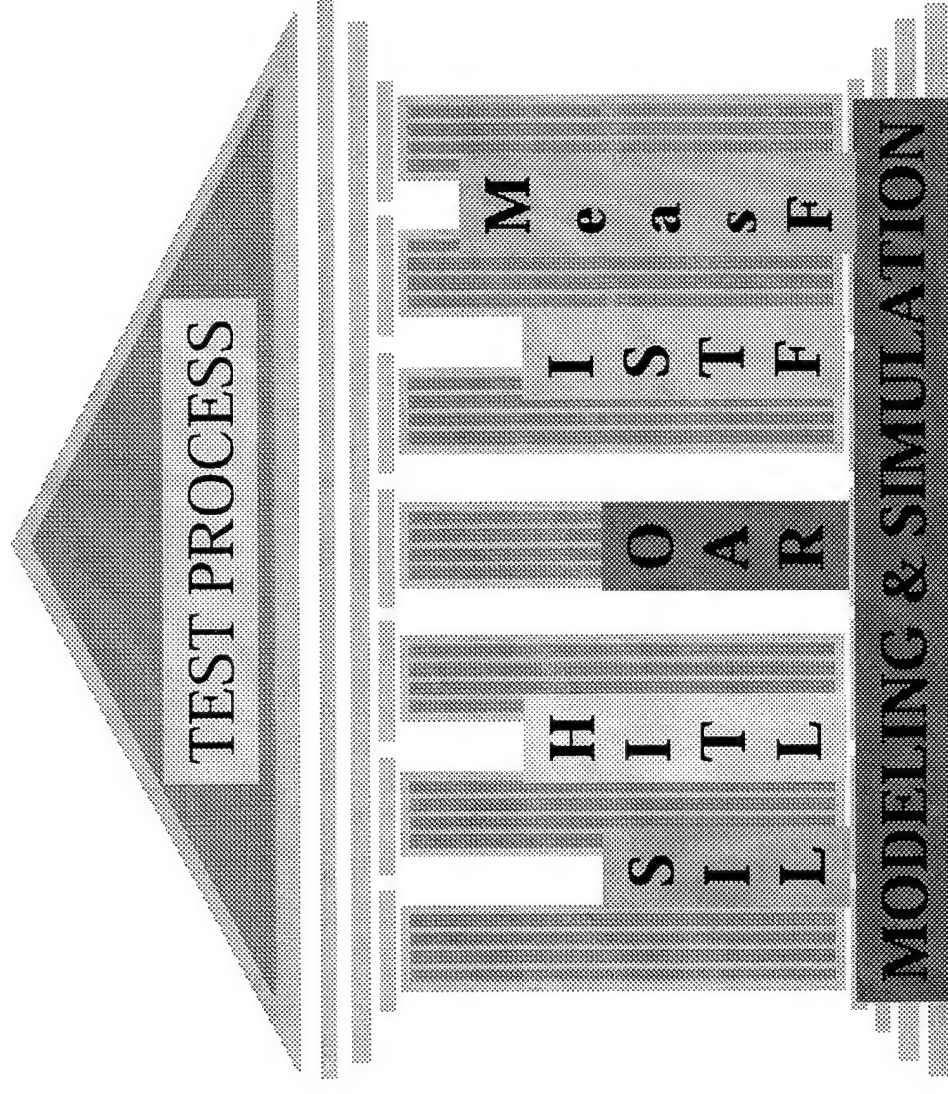
I wish to thank my co-workers and management in the Electronic Warfare Management Directorate, Robins AFB, GA for the opportunity, support and cooperation in providing material and editorial comments. In particular, contributions of Mr. Frank Sasso and Mr. Wayne Williams concerning some of the figures/illustrations. Also, note that the opinions expressed within this paper are of the author and are not necessarily those of the organization.

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[http:// www. xp.hq.af.mil/xpx/21/core.htm](http://www.xp.hq.af.mil/xpx/21/core.htm).
2. E. Jeffrey Conklin and William Weil, "Wicked Problems: Naming the Pain in Organization", 1997, [http:// www.gdss.com/wicked.htm](http://www.gdss.com/wicked.htm).

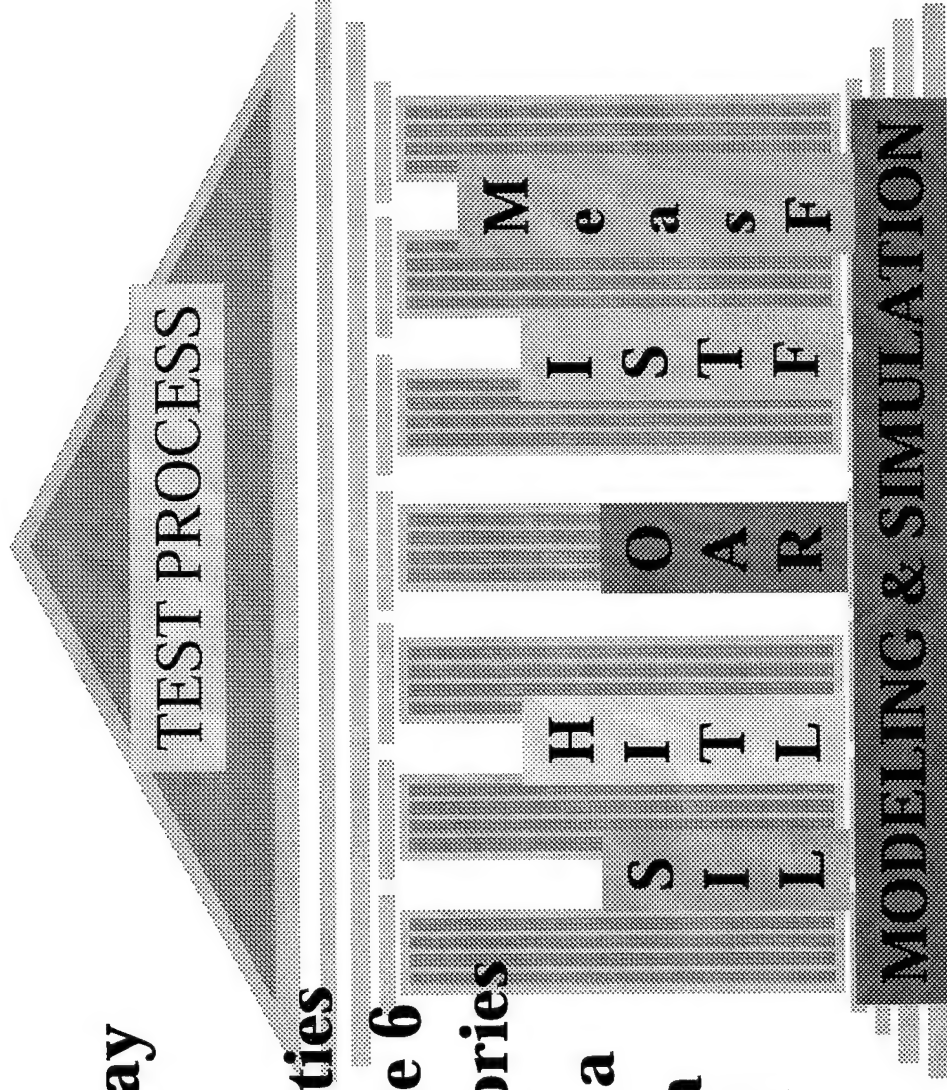
Modeling & Simulation

- Overview
- Description
- Role
- Questions



OVERVIEW

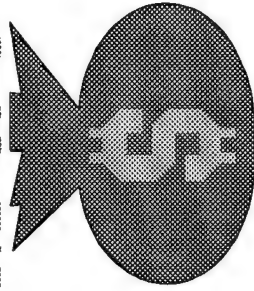
- all have role to play
- variations exist between the facilities grouped into these 6 test facility categories
- each can provide a rigorous test for a system under test



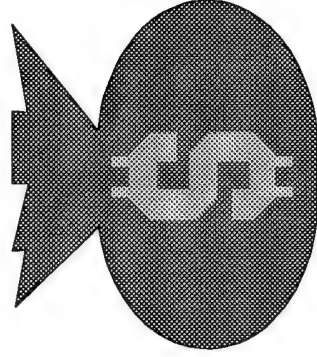
OVERVIEW-- Relative Cost

Utilization

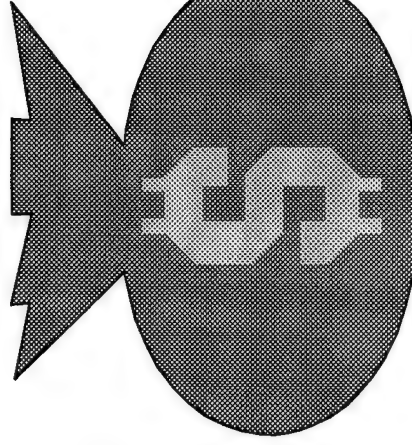
M & S



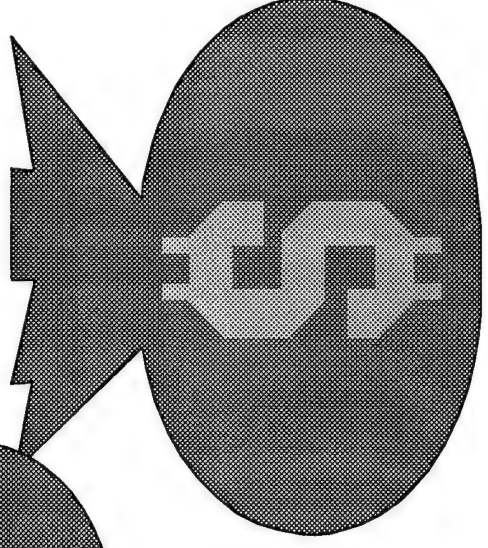
SIL



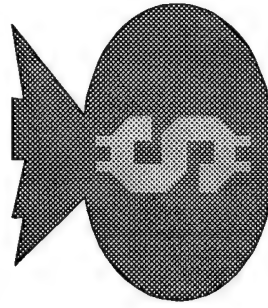
ISTF



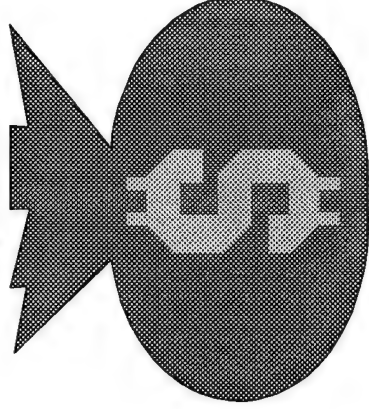
OAR



MEASUREMENT

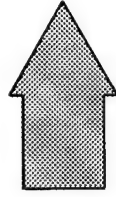


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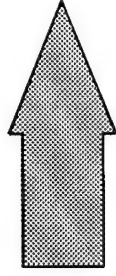


OVERVIEW-- TEST TRIALS vs TIME

OAR



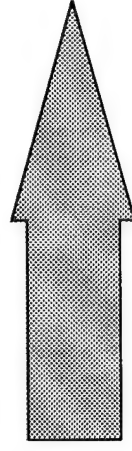
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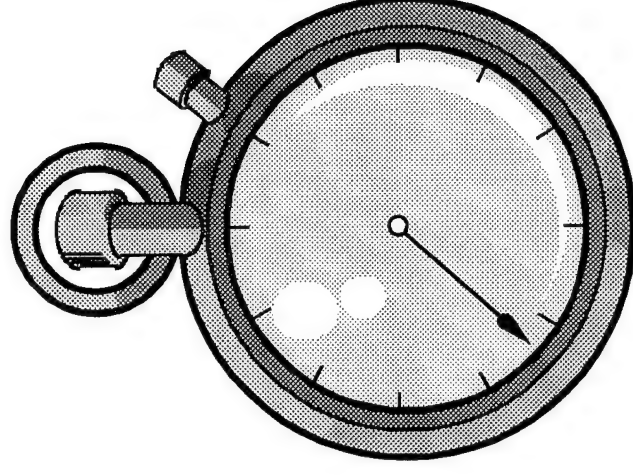
SIL



M&S

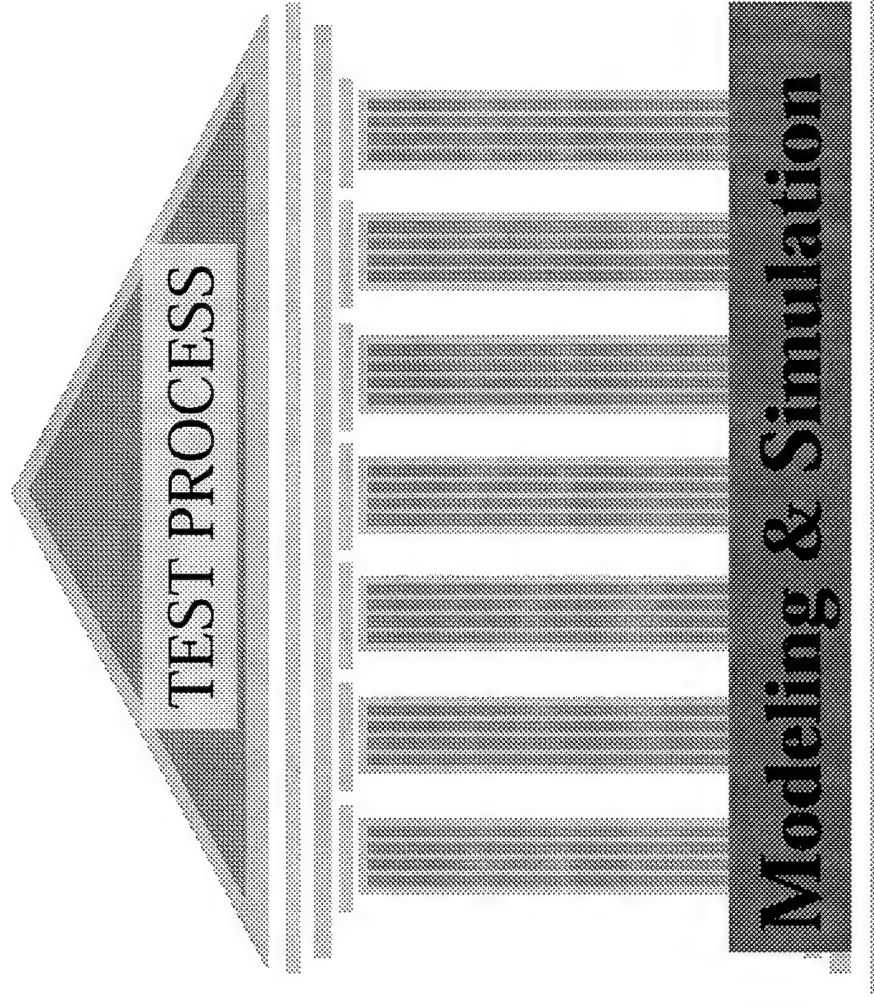


MEASUREMENT **Not applicable**



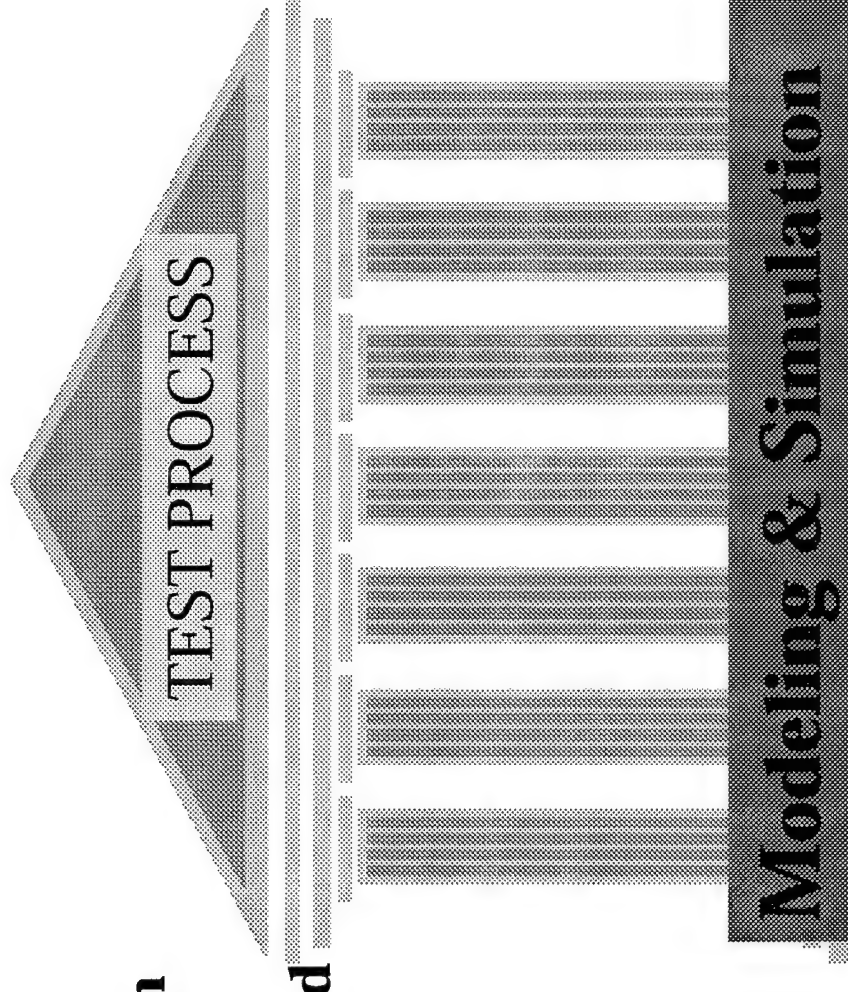
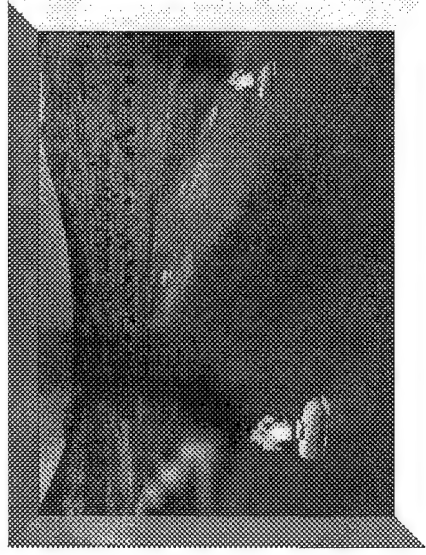
OVERVIEW

- **Definition**
- **Significance**
- “The issue is no longer whether extensive use of modeling and simulation tools has merit, but rather how to develop and apply a new acquisition process ...
**Dr. Patricia Sanders
OSD/DTSE&E**



DESCRIPTION

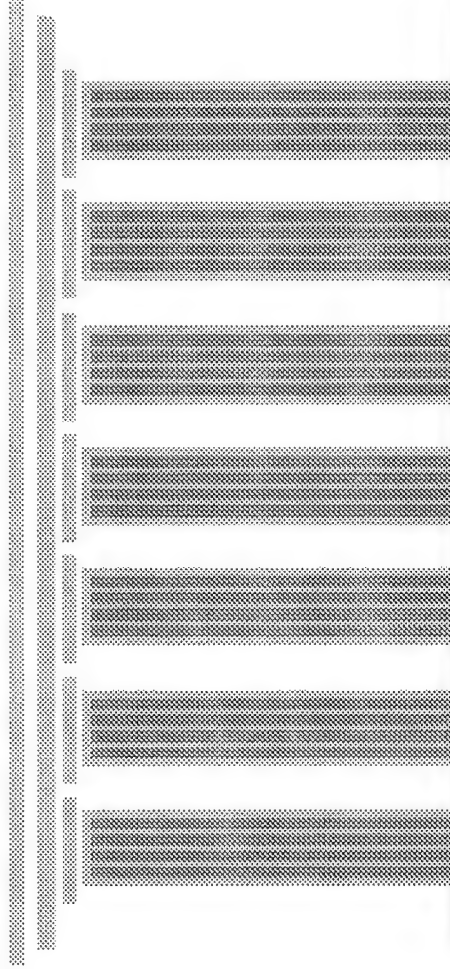
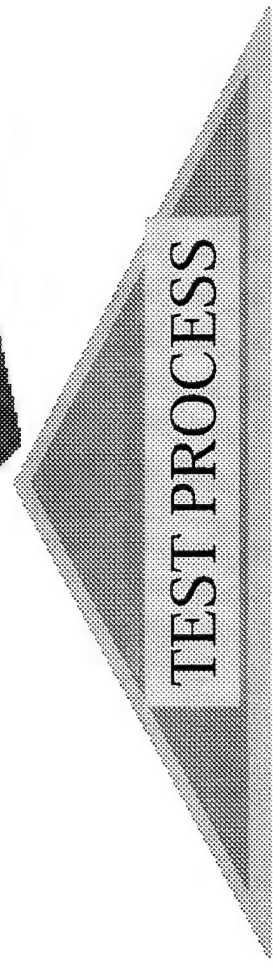
- “simple” to complex
- engineering to campaign levels
- limited to total simulated
- real and simulated interactive



ROLE

- Beginning to End
- Acquisition support
- Testing & Training
- “Modeling and Simulation will allow us to make better decisions, develop better warfighting skills, and demonstrate space and air power’s contribution to our national defense”

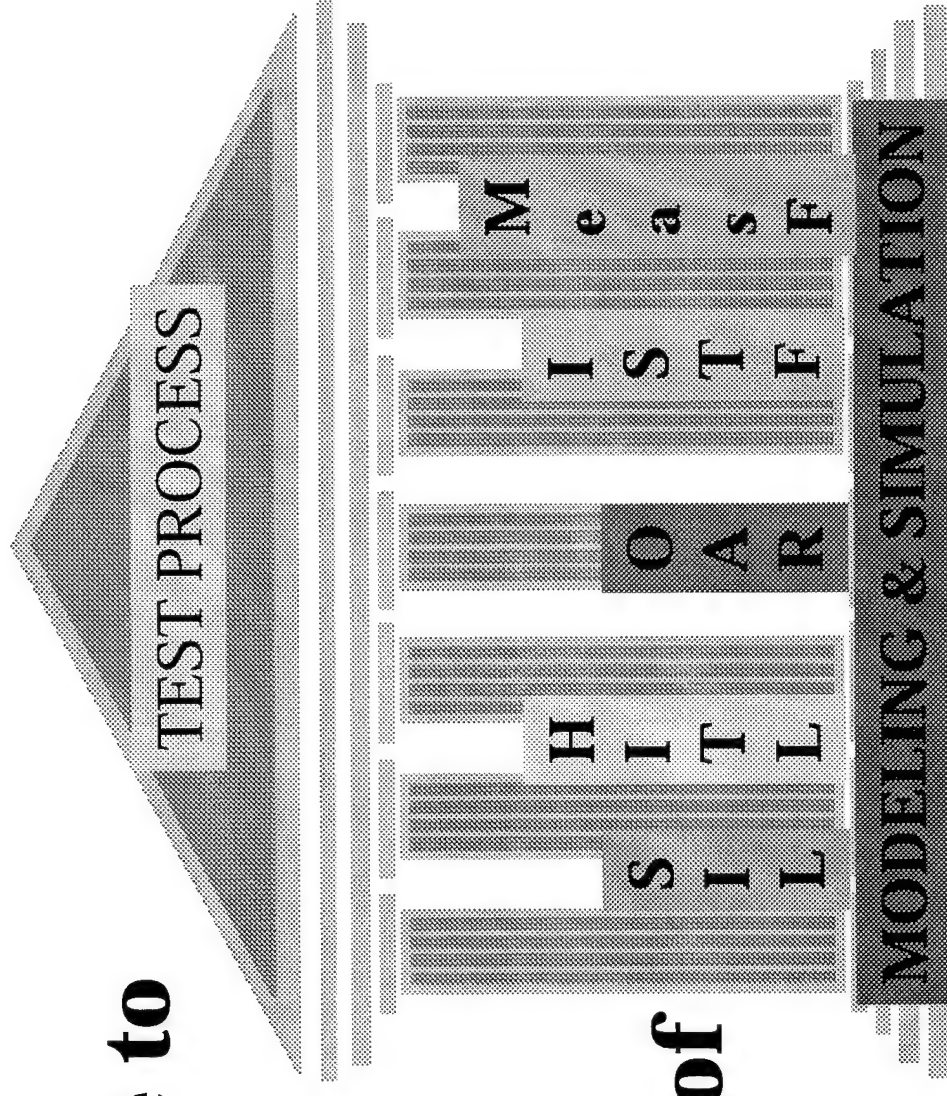
Col Jimmy Wilson
AFAMS



Modeling & Simulation

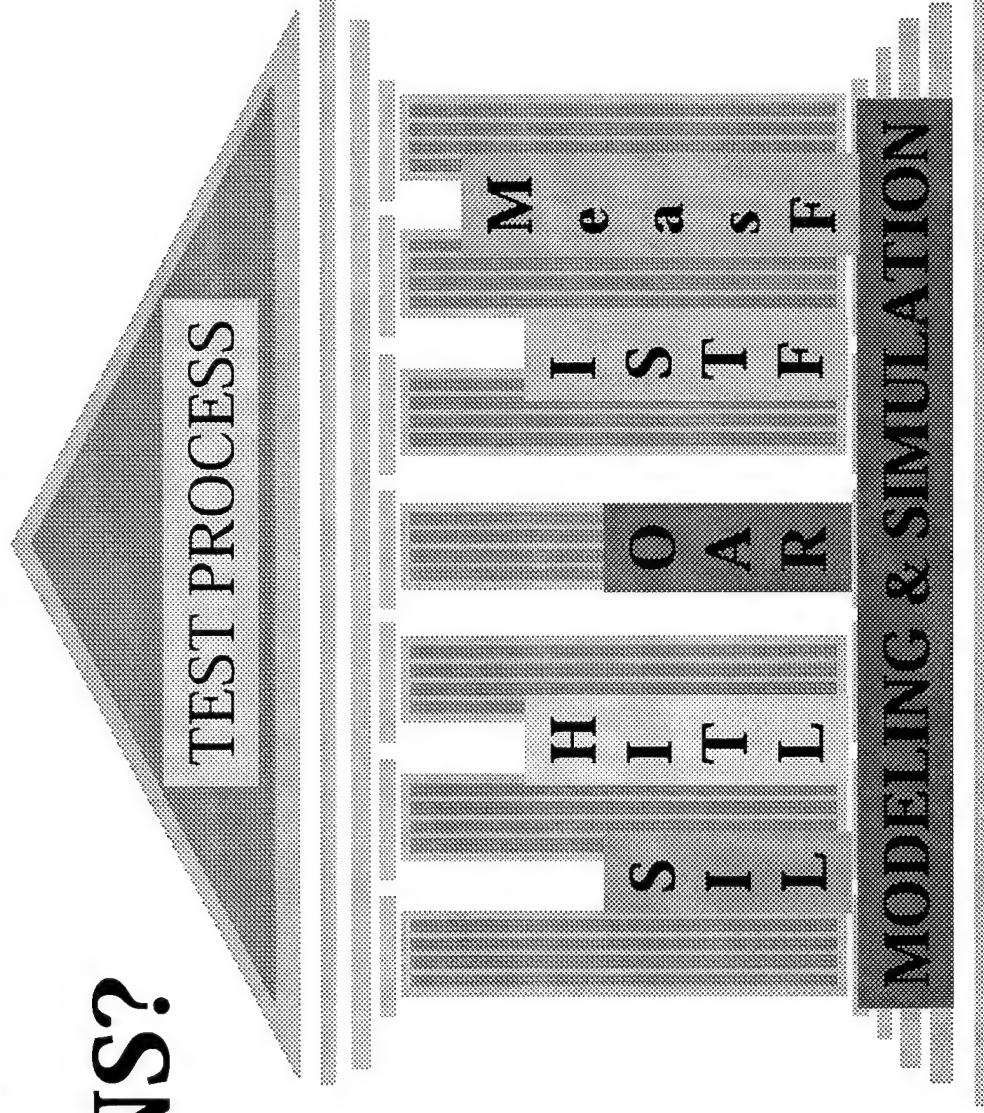
SUMMARY

- all have role to play
- all are necessary
- all are part of JAWS,S3



Modeling & Simulation

• QUESTIONS?





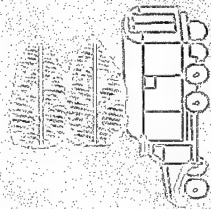
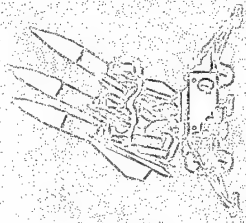
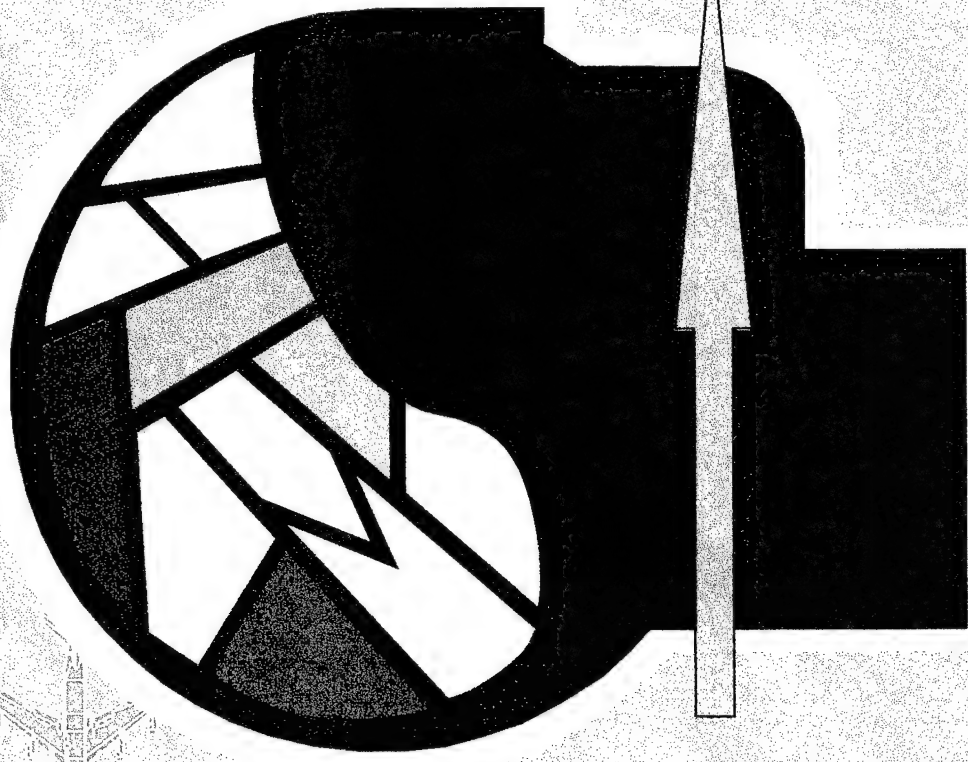
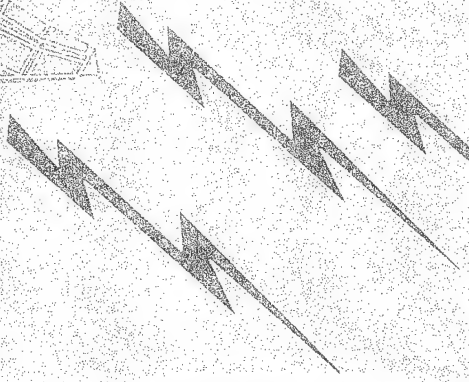
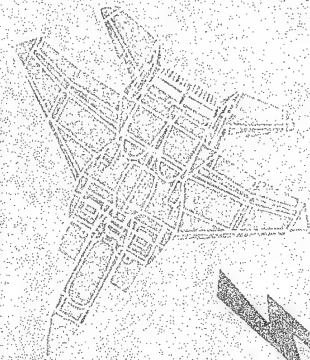
Jerome M Smith
WR-ALC/LNEV
DSN 468-3691



The SIMULATION *CHALLENGE*

- the challenge
- a process of handling the challenge
- technology employed or needed
- process-people-technology relationship

The Challenge



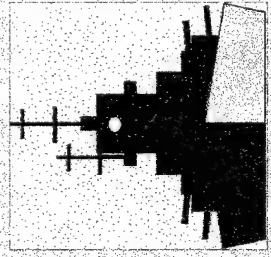
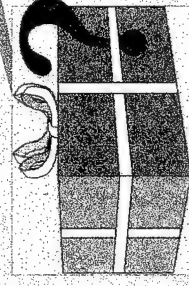
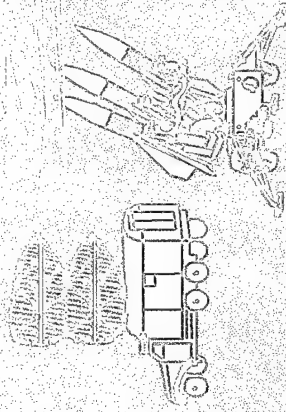
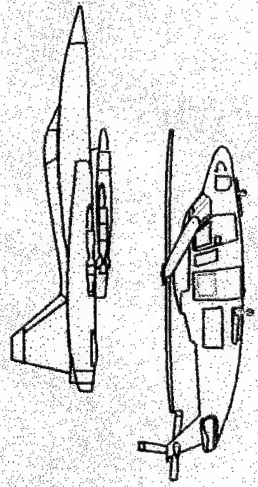
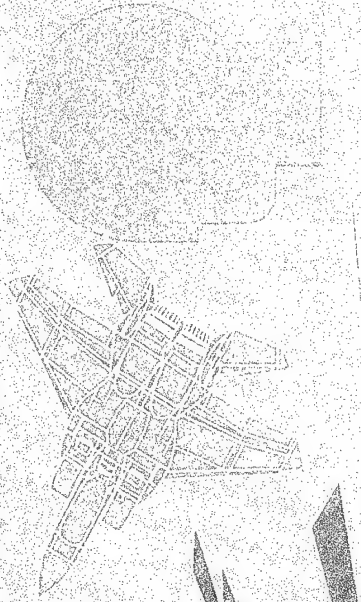
Simulation

Information

The CHALLENGE

- not unique to System Integration Labs (SILs)
- three aspects:
 - 1) acquisition of information
 - 2) implementation of process
 - 3) retention & dissemination
- Adequate simulation is highly sought after

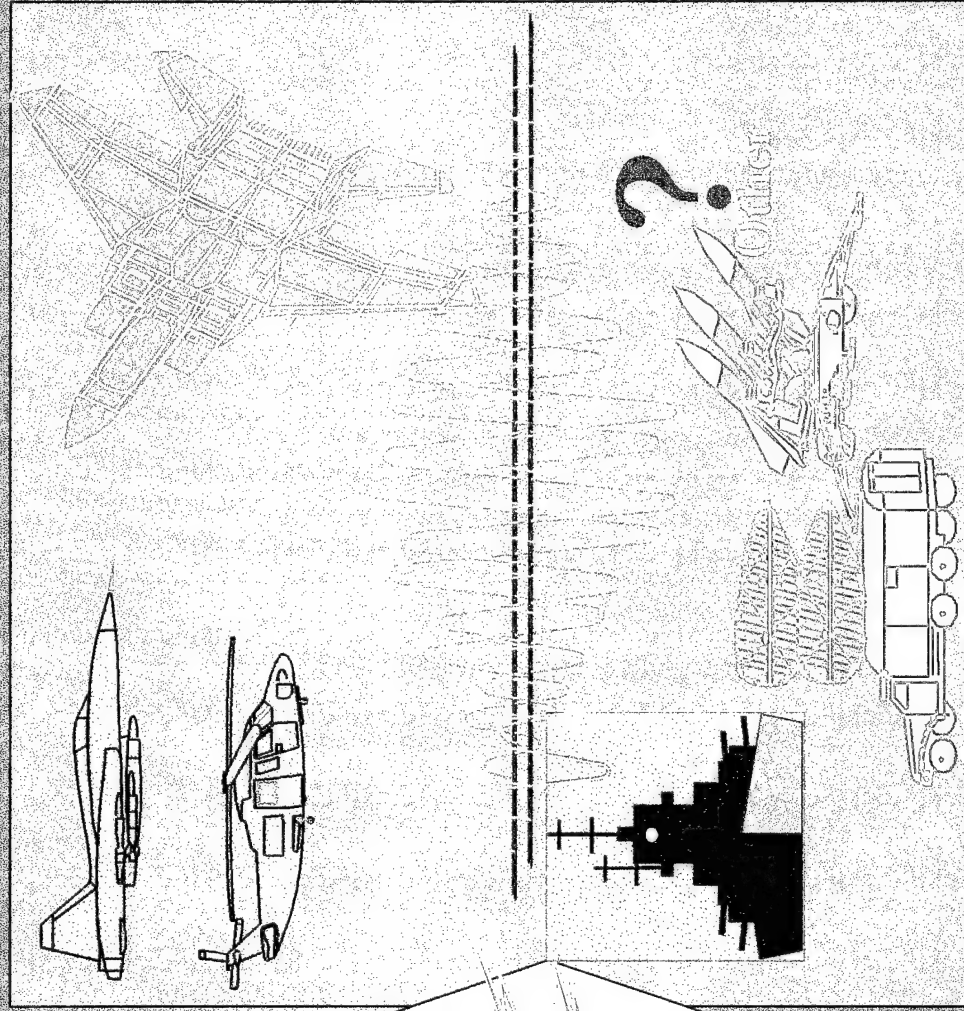
ELECTRONIC WARFARE



**Identify
Neutralize**

NUMBER ??

COMPONENTS OF SIMULATION



PURPOSE

Threat Changes
Tactics
Hardware MODS
Performance Enhancements
Logistical Needs

requirements

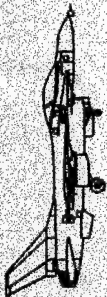
DEVELOP
CHANGE

TEST
CHANGE

distribute
change

install
change

mission capable
aircraft



EWASIF

ALR-69

ALR-56M

ALR-69

ALR-56 PT

ALIC

ALQ-172

SI

ALR-46
(V)4

ALQ-155

ALQ-172

ALQ-161

APR-39

ALQ-162

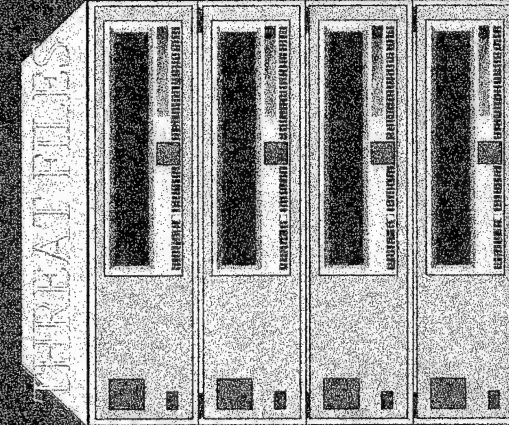
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BLOCK II

ALR-56M

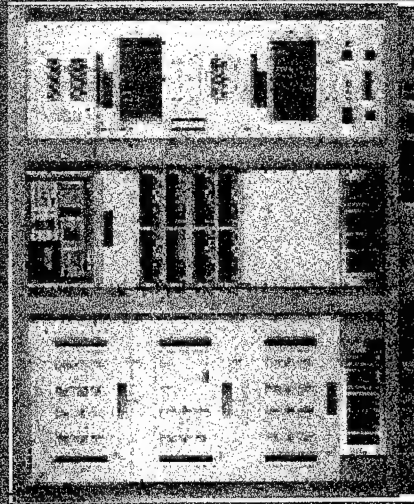
ALQ-184

ALQ-135

THREAT FILES



THREAT SIMULATORS

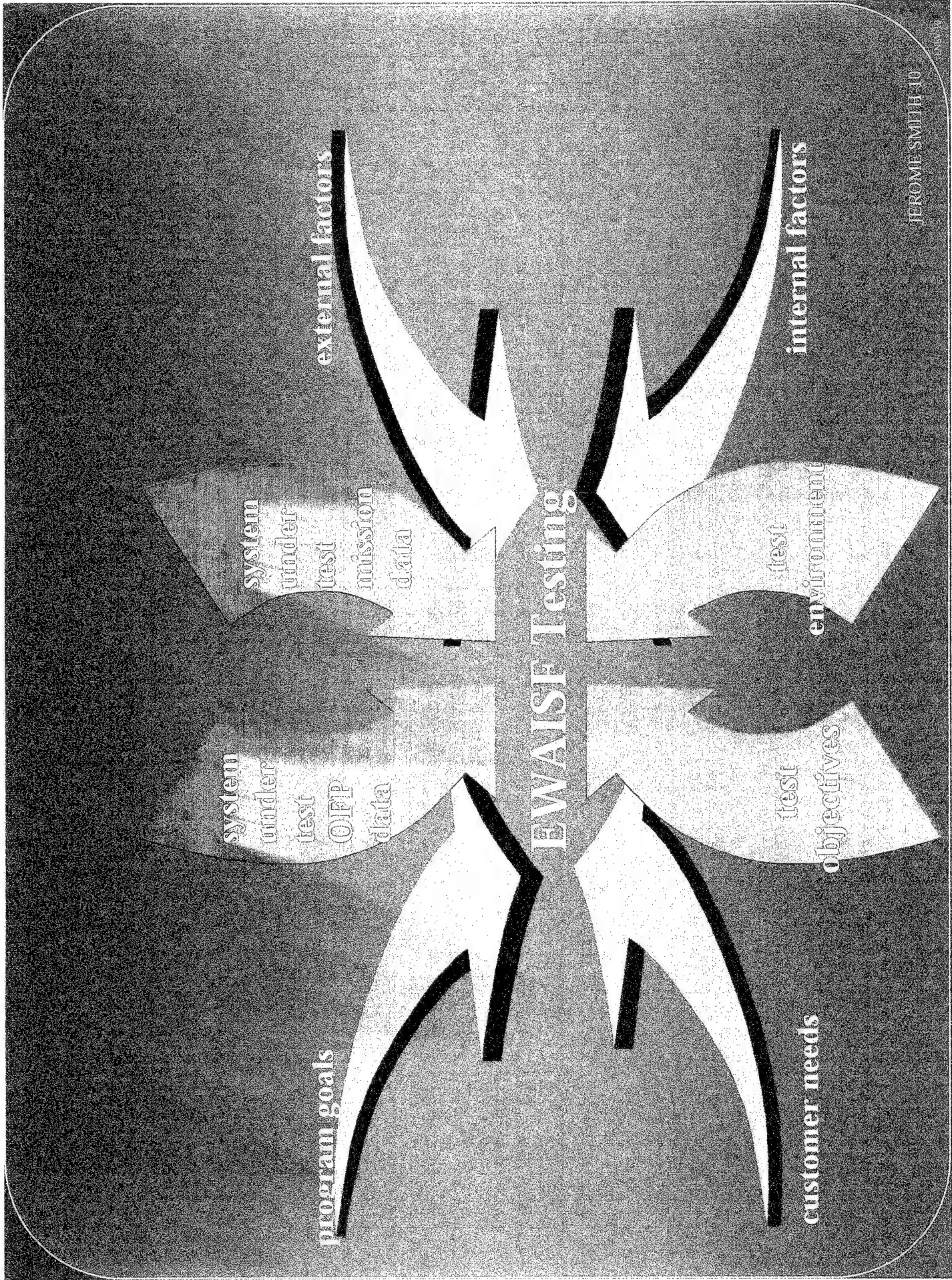


15 in number

4 000 plus & increasing

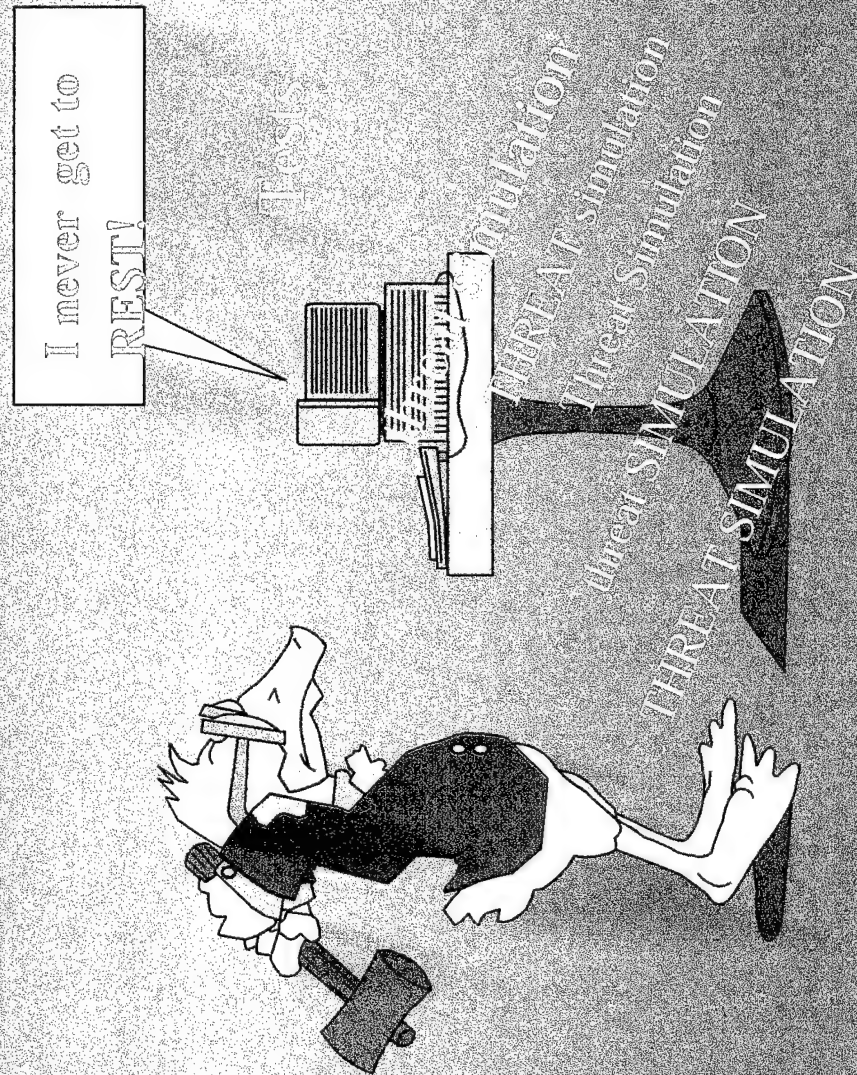
Jerome Smith-7

1011



JEROME SMITH-10

Simulation, our Process



HEROME SWEET

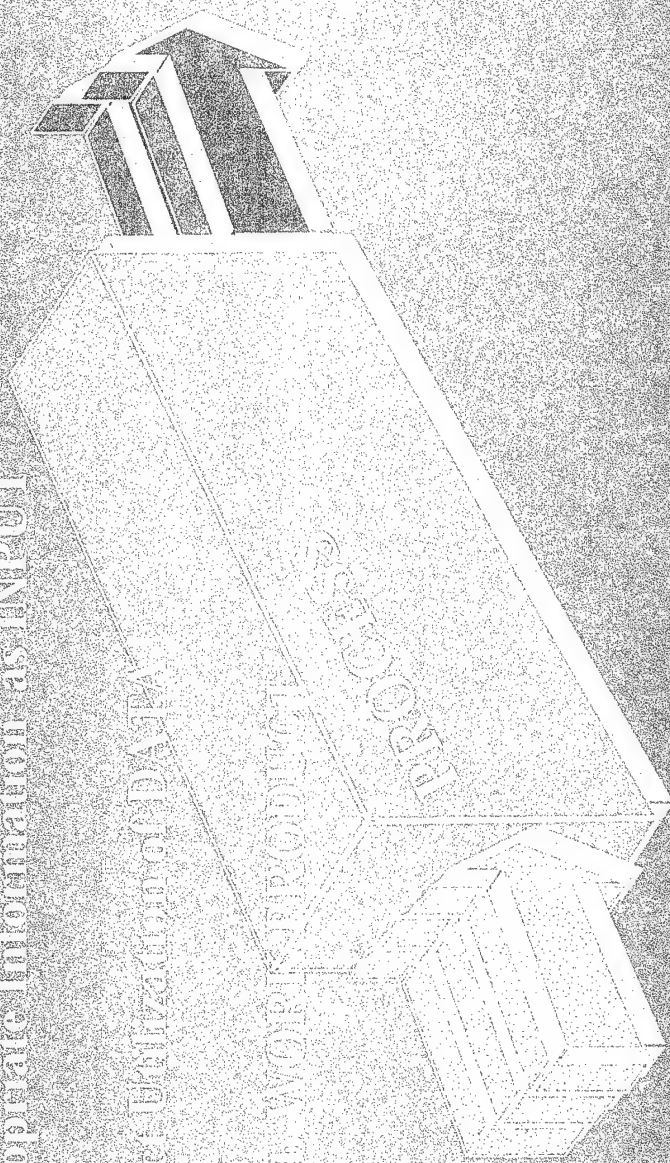
The IDEAL

• Appropriate Information as INPUT

• Proper Utilization of DATA

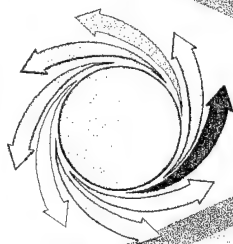
• Effective WORK PRODUCT

• PROGRESS



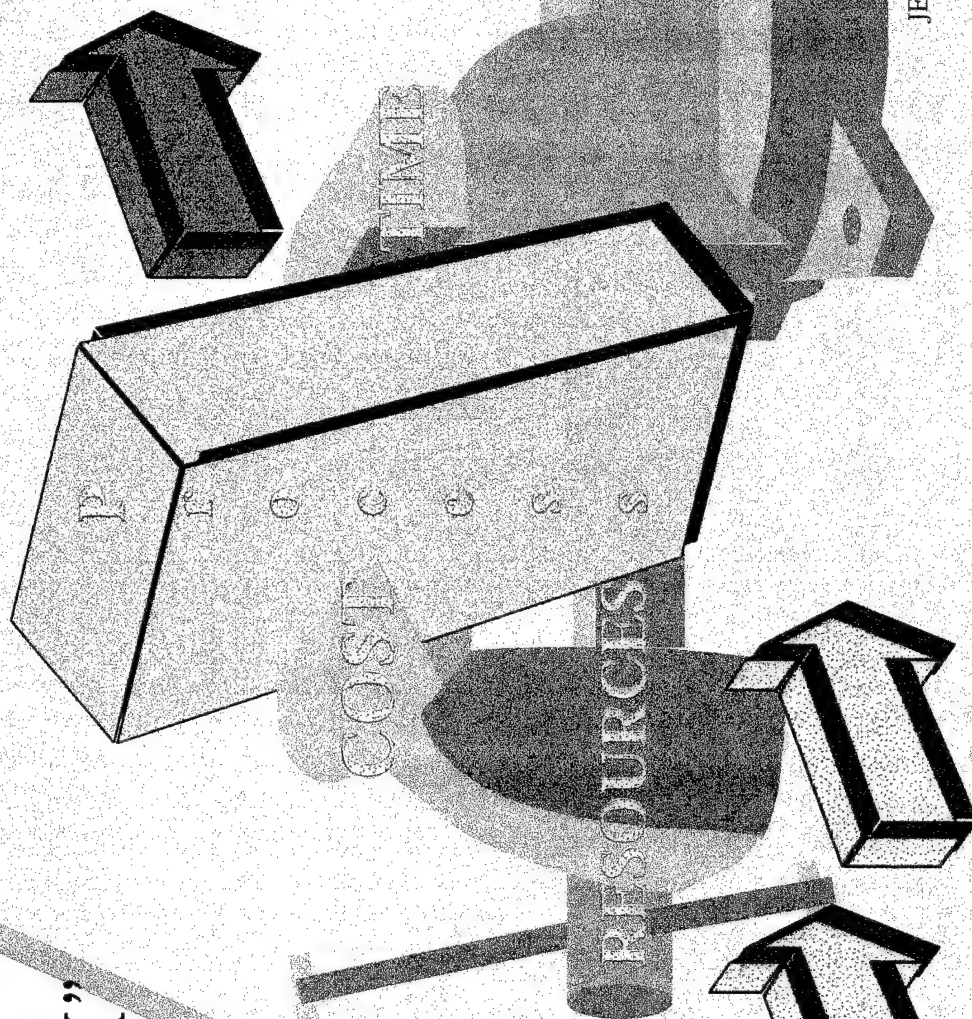
OUR REALITY

“WICKED
PROBLEM”



Data

Issues



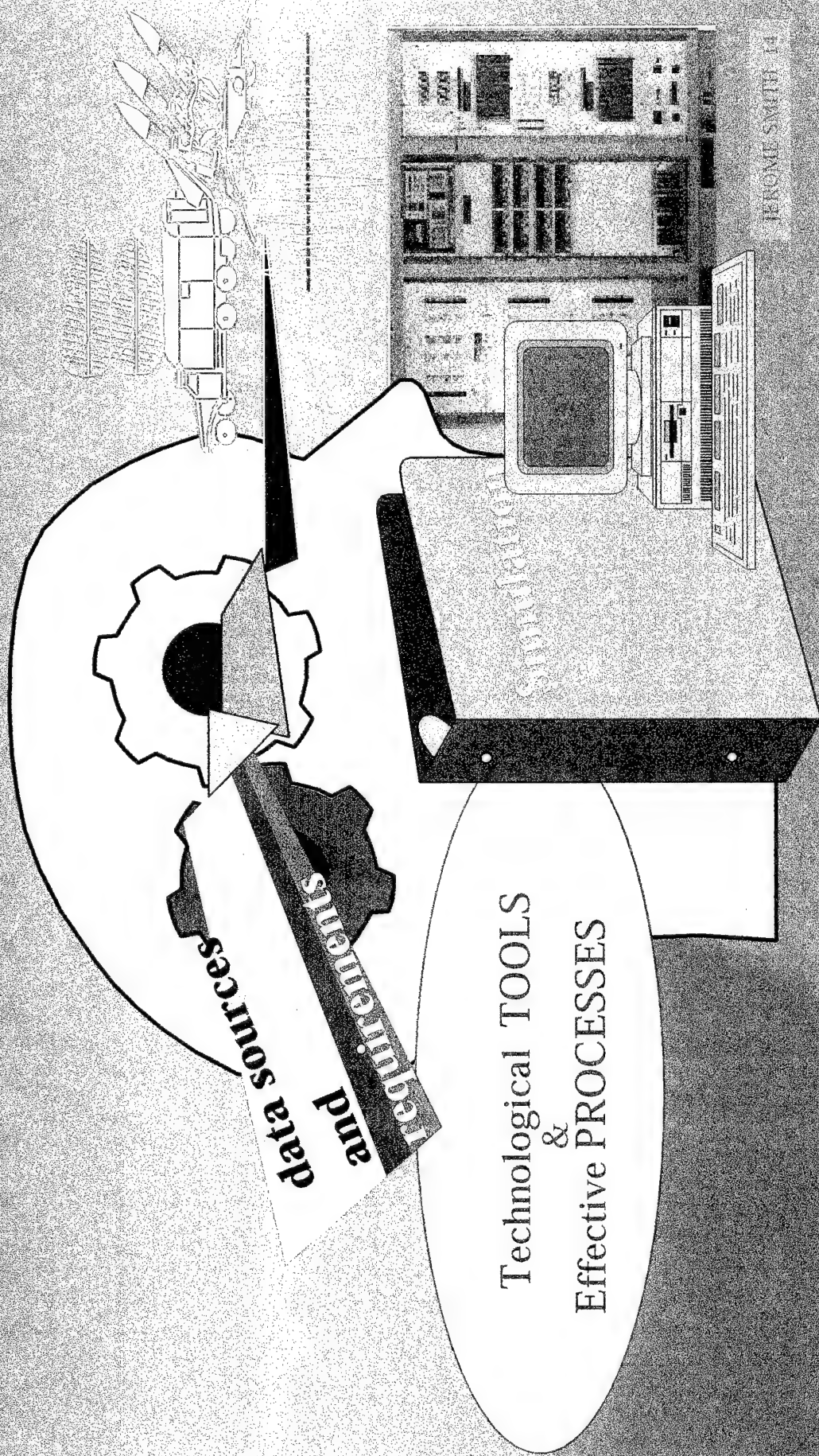
JEROME SMITH-13

LAEV-13

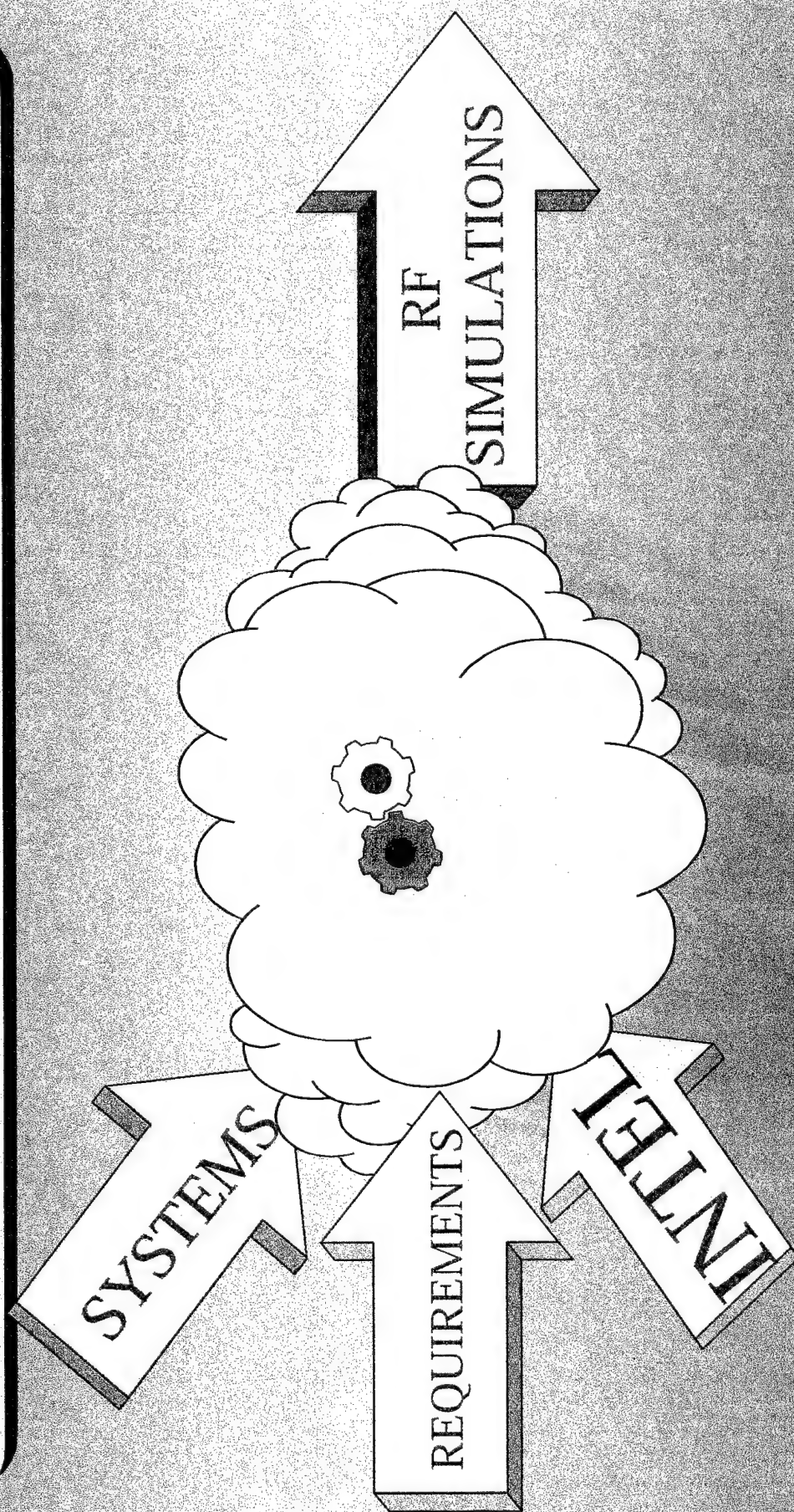
IDEAL versus Reality

- complete information & requirements
- perfect management, manipulation & use
- right quantity, absolute technical accuracy, and perfect utility
- incomplete & often changing cost & resource constraints
- platform variations & capabilities/limitations

Simulation BASICS



Developing Simulations “The PROCESS”



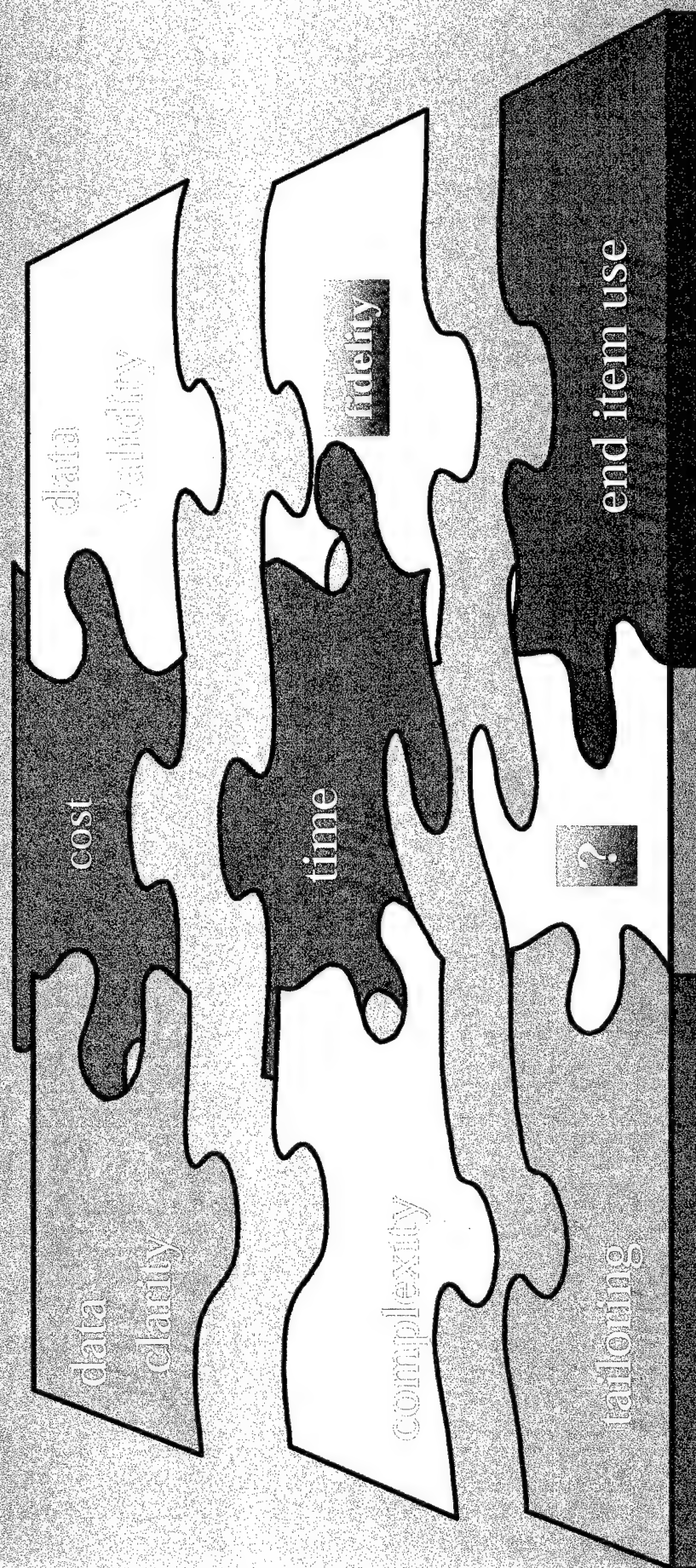
PROCESS

- Definition phase
- Implementation phase
- Application phase

Signal Definition



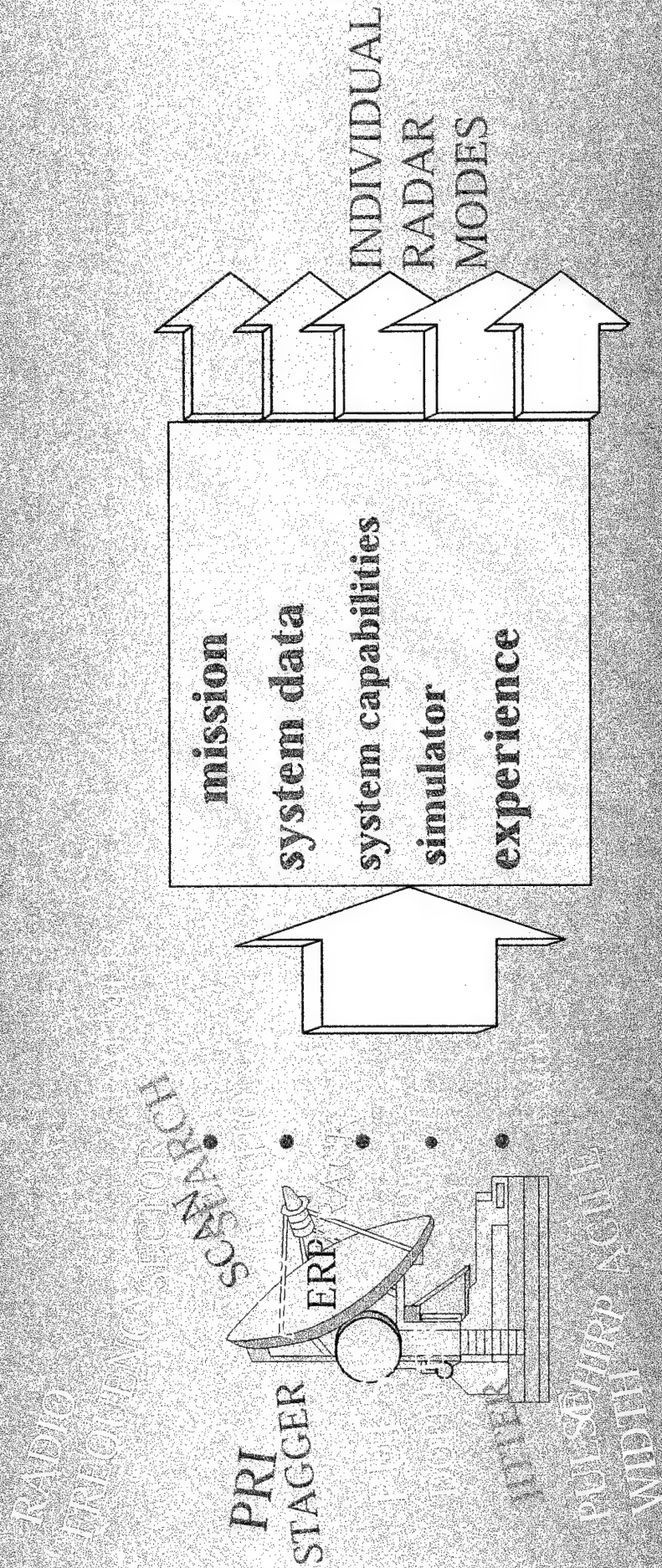
ISSUES



The 4 C's

- Constraints -- schedule, resource, cost
- Complexity -- requirements through dissemination
- Components -- expertise, methods, technology tools, partnerships
- Criticality -- “prime time” warfighter support

MODE Definition



"AUTOMATION"

Scan Type:

Electronic

Pulse Type:

User Defined Pulse Train

Signal Power

Amplitude Parameters

Scan Parameters

Pulse Parameters

Enter # of Pulses:

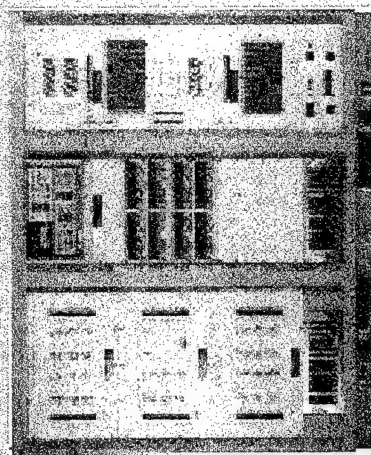
3

OK

DEF Window							▼	▲
Tree:	Suffix:	Measurement:	Units:	Lower:	Upper:	Nominal:	Comments:	▶
5.6		Pulse Type: User Defined Pulse Train //						
5.6.1		Repeat Pulse	Integer					
5.6.2		Sequence Repeat	Integer					
5.6.3		Basic Clock Period	µSec					
5.6.4		Range of Countdowns Used	Integer					
5.6.5		Sequence # (Repeatable Data Entry)	Integer					
5.6.5.1		Pulse # (Repeatable Data Entry)	Integer					
Record: 20		of 20	▶▶	◀◀				▶

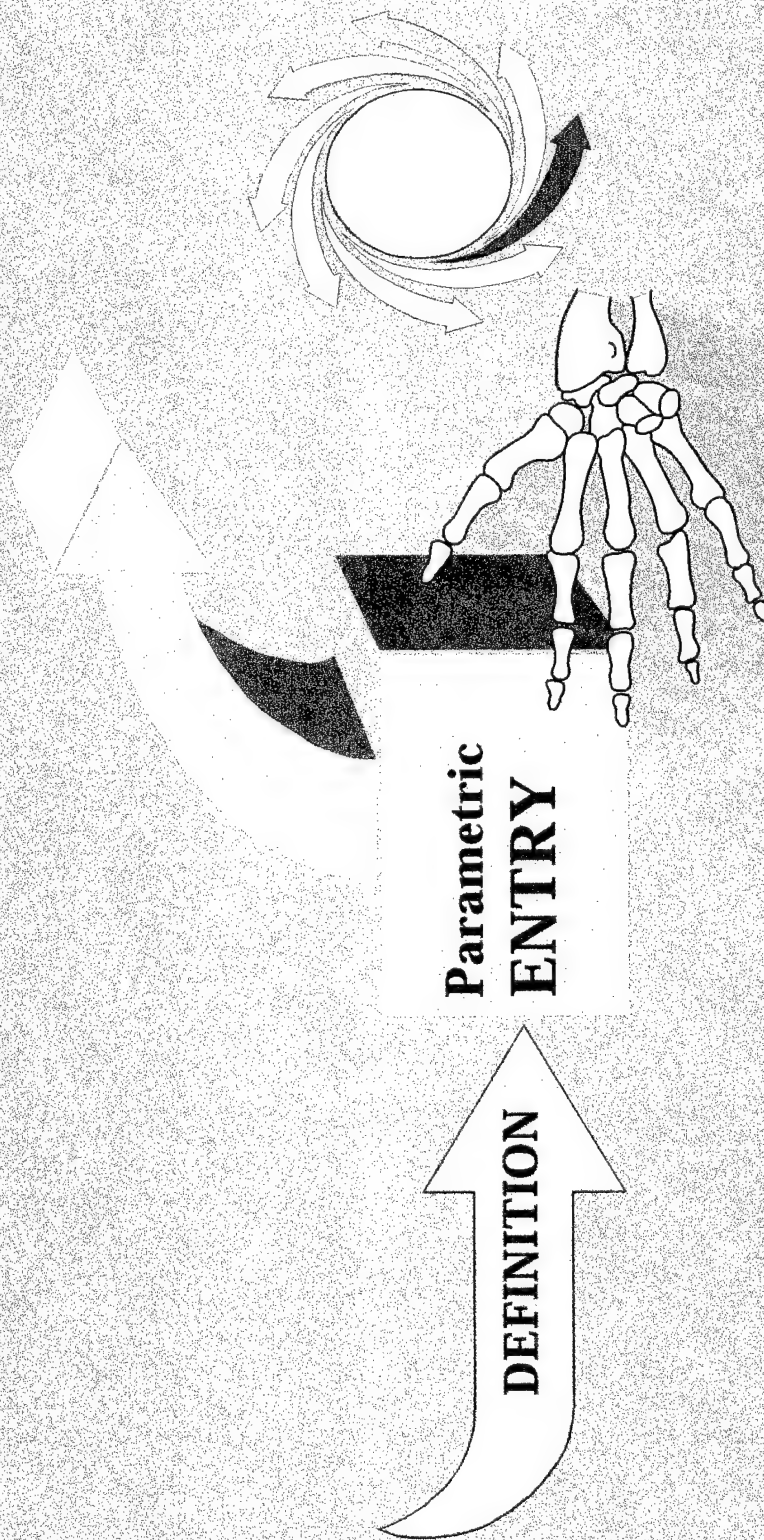
Signal Implementation

Item	Subitem	Measurement	Unit	Lower	Upper	Manual	Comments
5.6	Rate Test	Rate (per second)	Hz				
5.6.1	Repeat Pulse		Hz				
5.6.2	Sequence Repeat		Hz				
5.6.3	Base Clock Period		Hz				
5.6.4	Range of Clock Values Used		Hz				
5.6.5	Sequence Affected by Data Error		Hz				
5.6.5.1	Rate of Error		Hz				
5.6.5.1.1	Rate of Error		Hz				

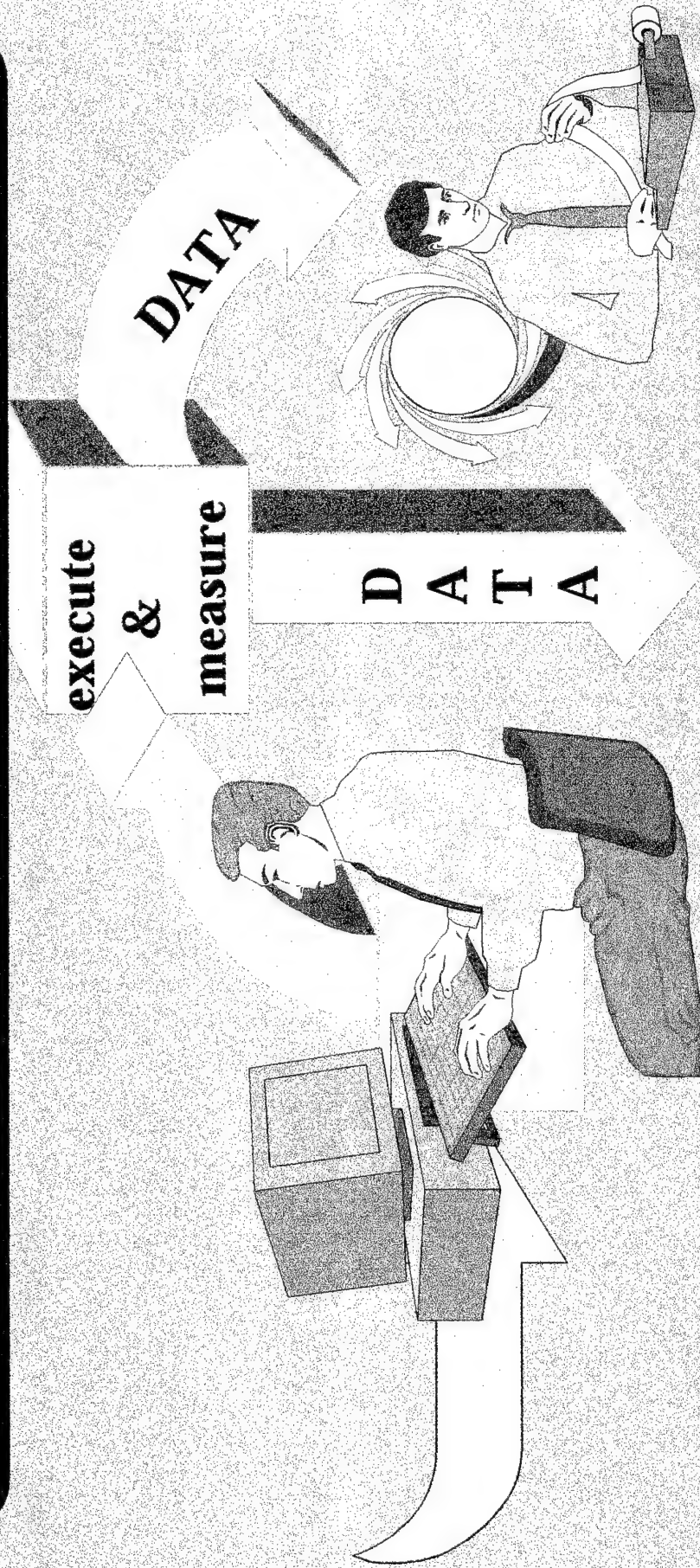


PROVINCIAL 24

IMPLEMENTATION

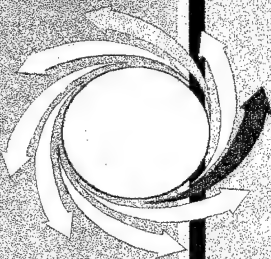


IMPLEMENTATION

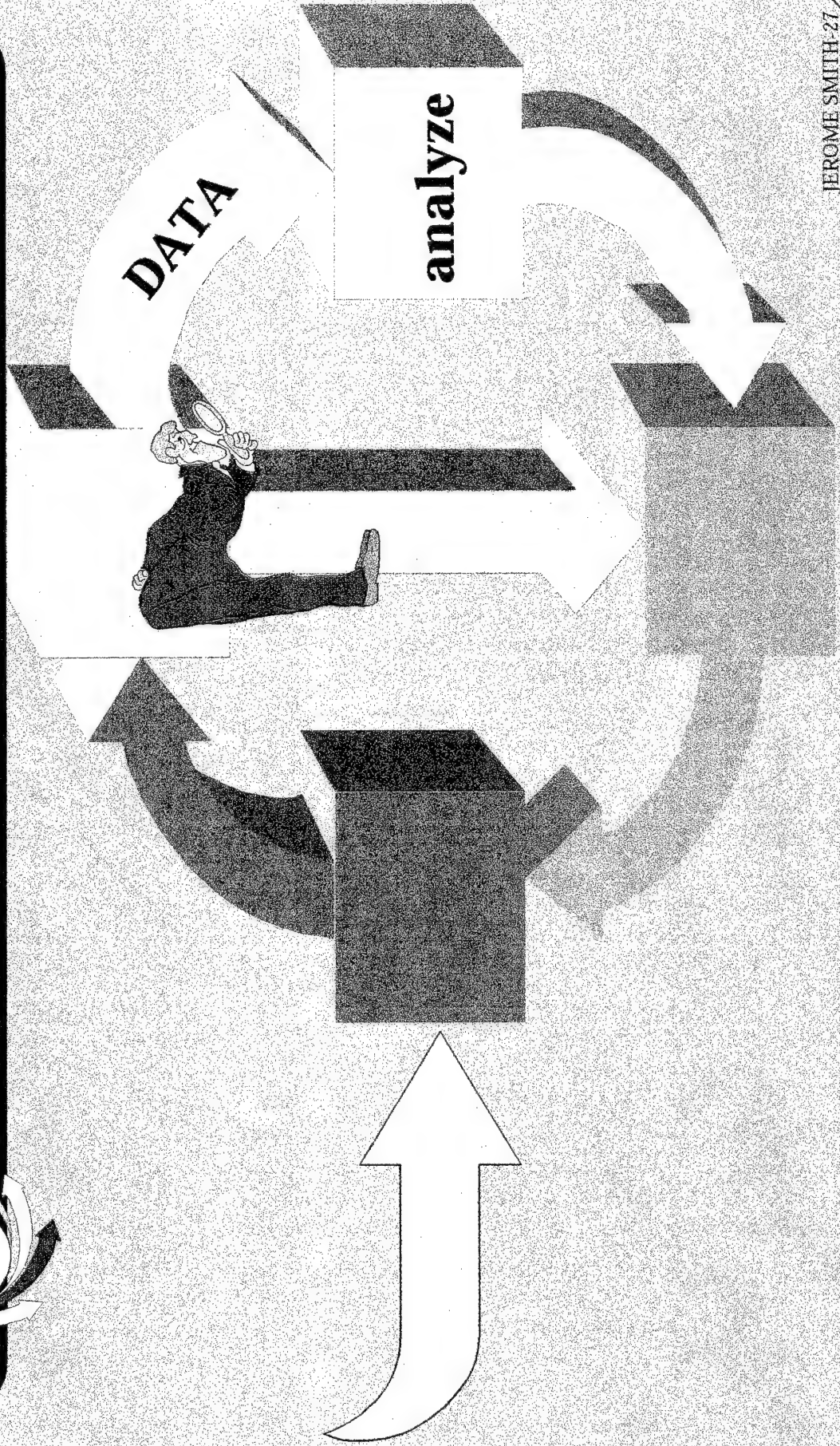


JEROME SMITH 26

LINEA 25

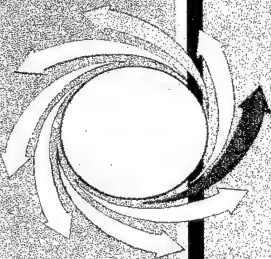


IMPLEMENTATION

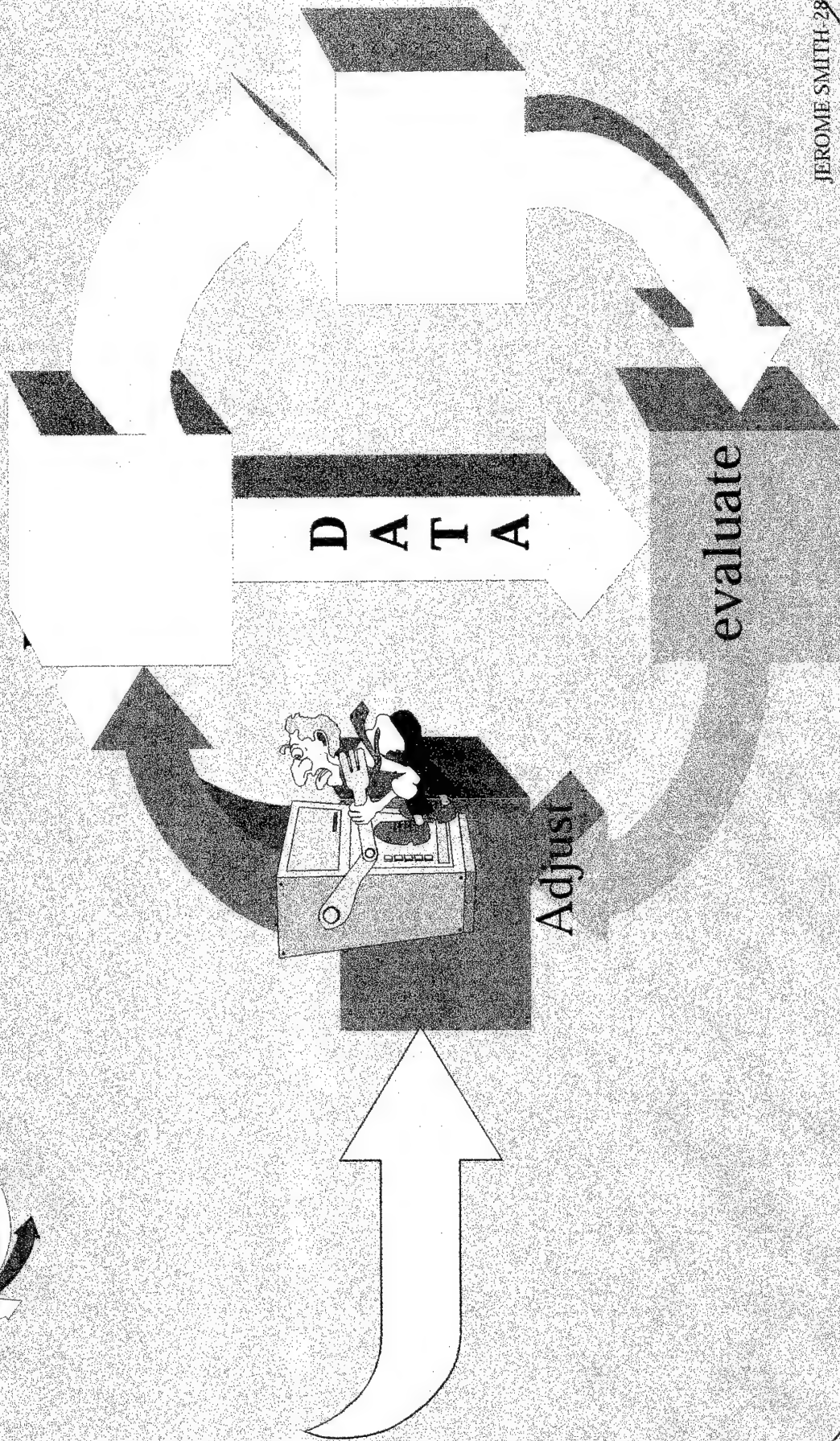


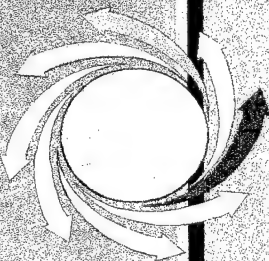
JEROME SMITH 27

L. NEV. 28

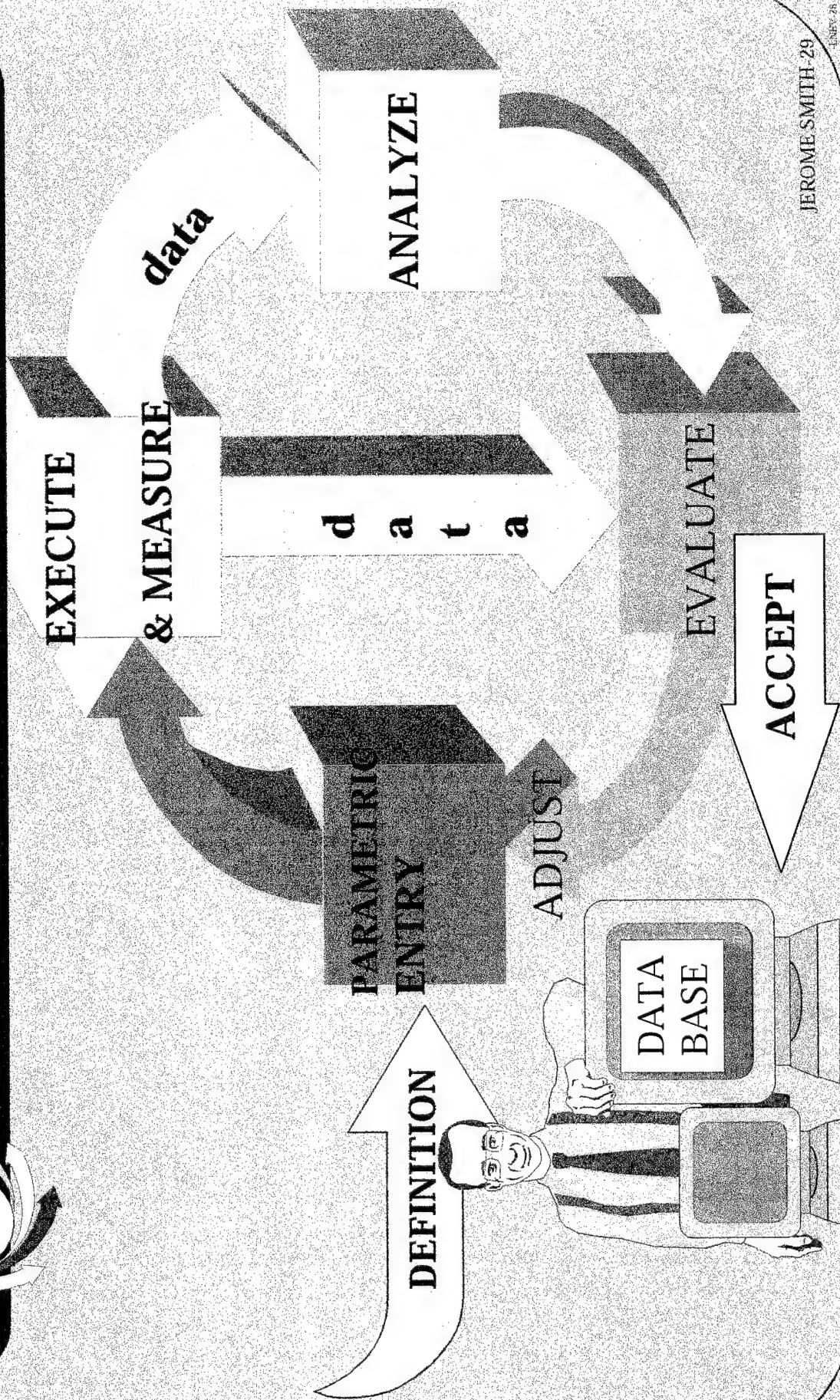


IMPLEMENTATION

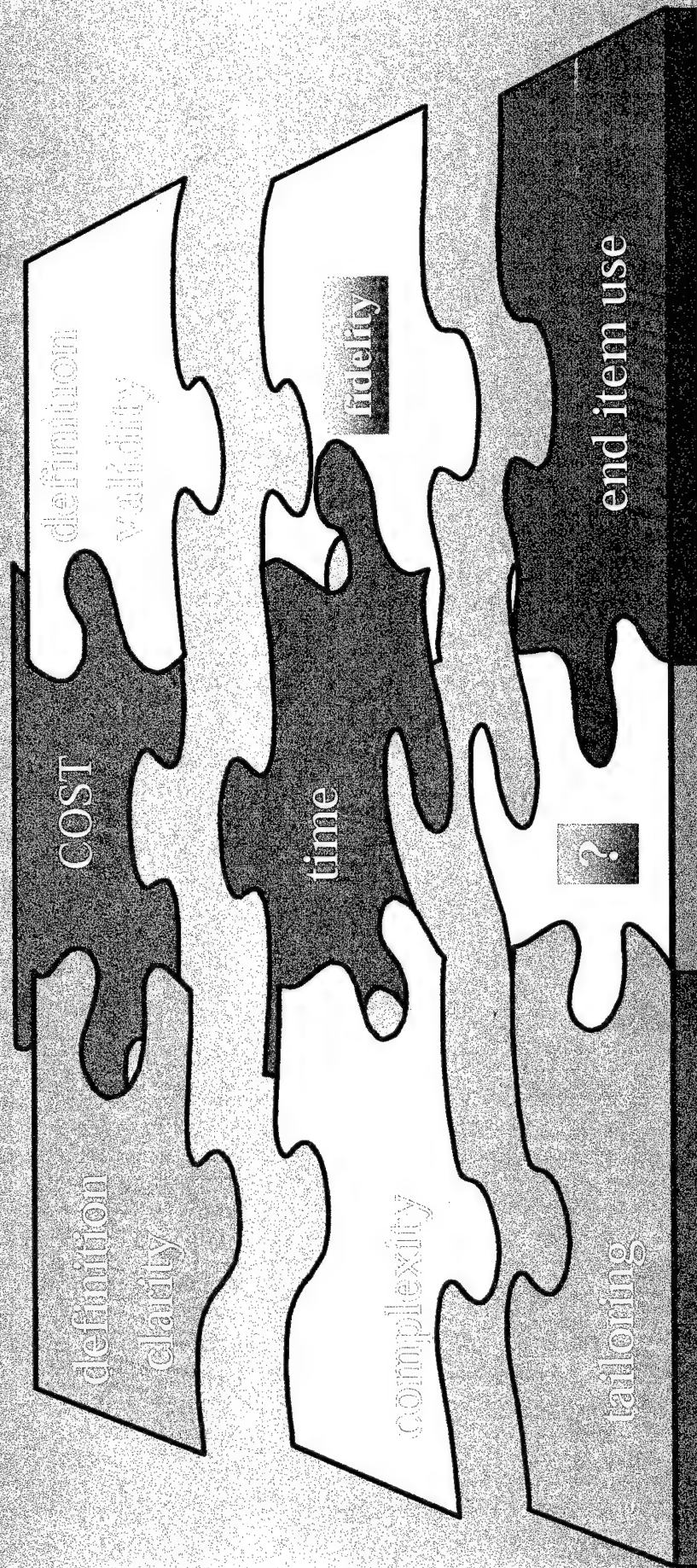




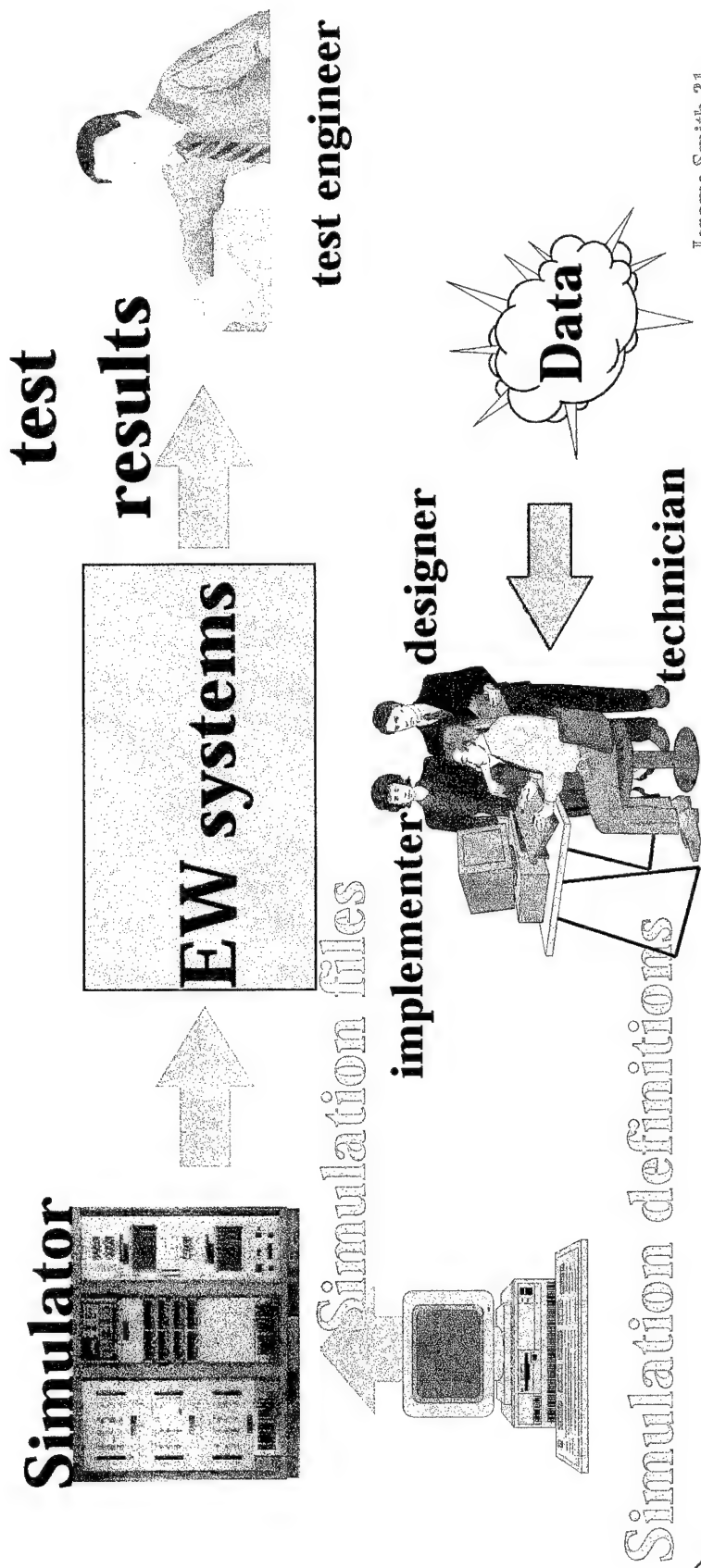
IMPLEMENTATION



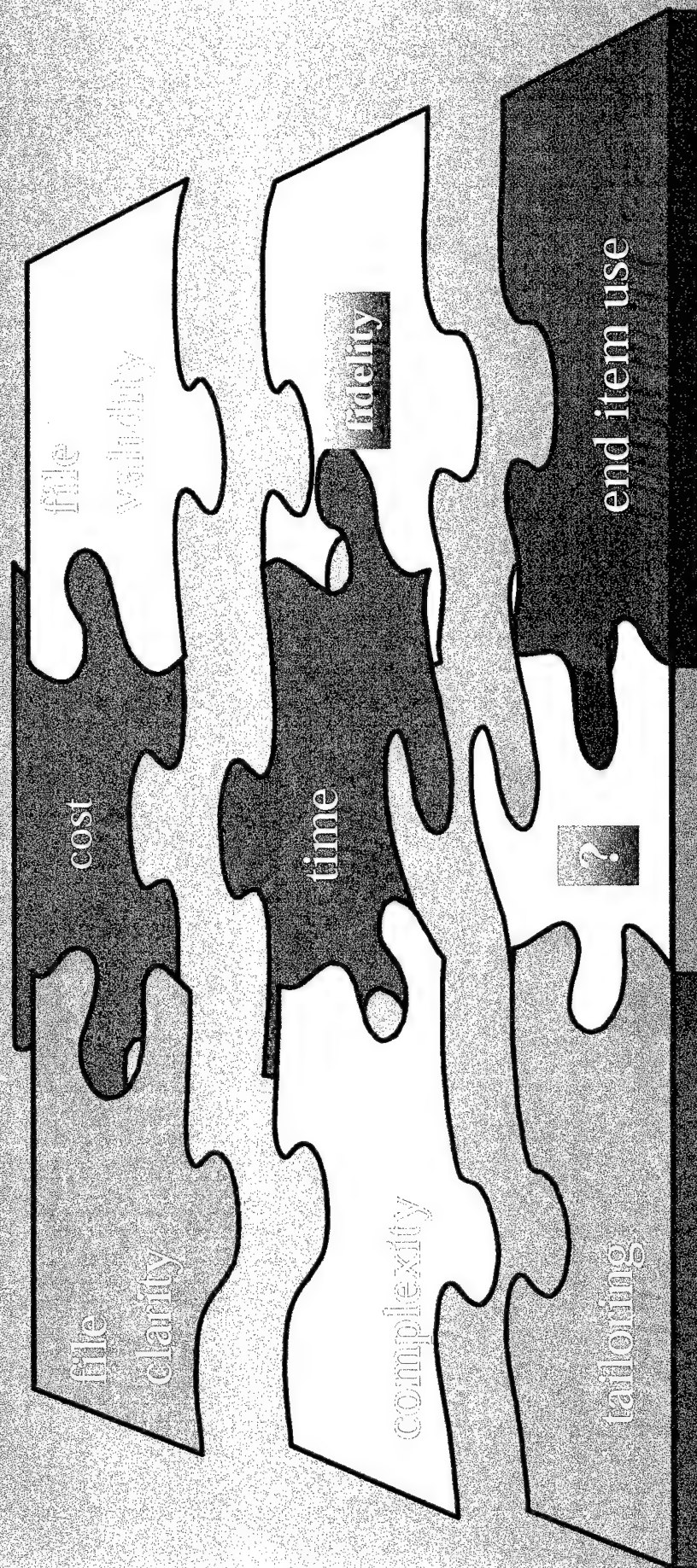
ISSUES



APPLICATION

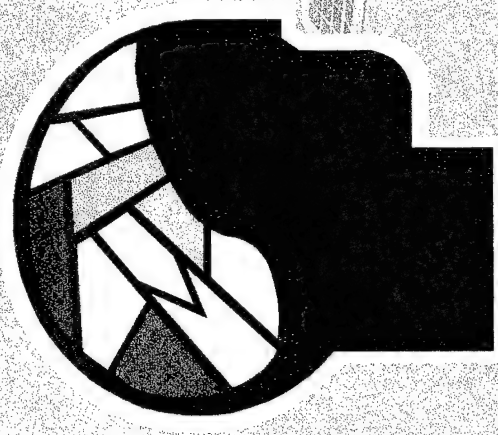


ISSUES



APPLICATION

IMPLEMENTATION



TEST

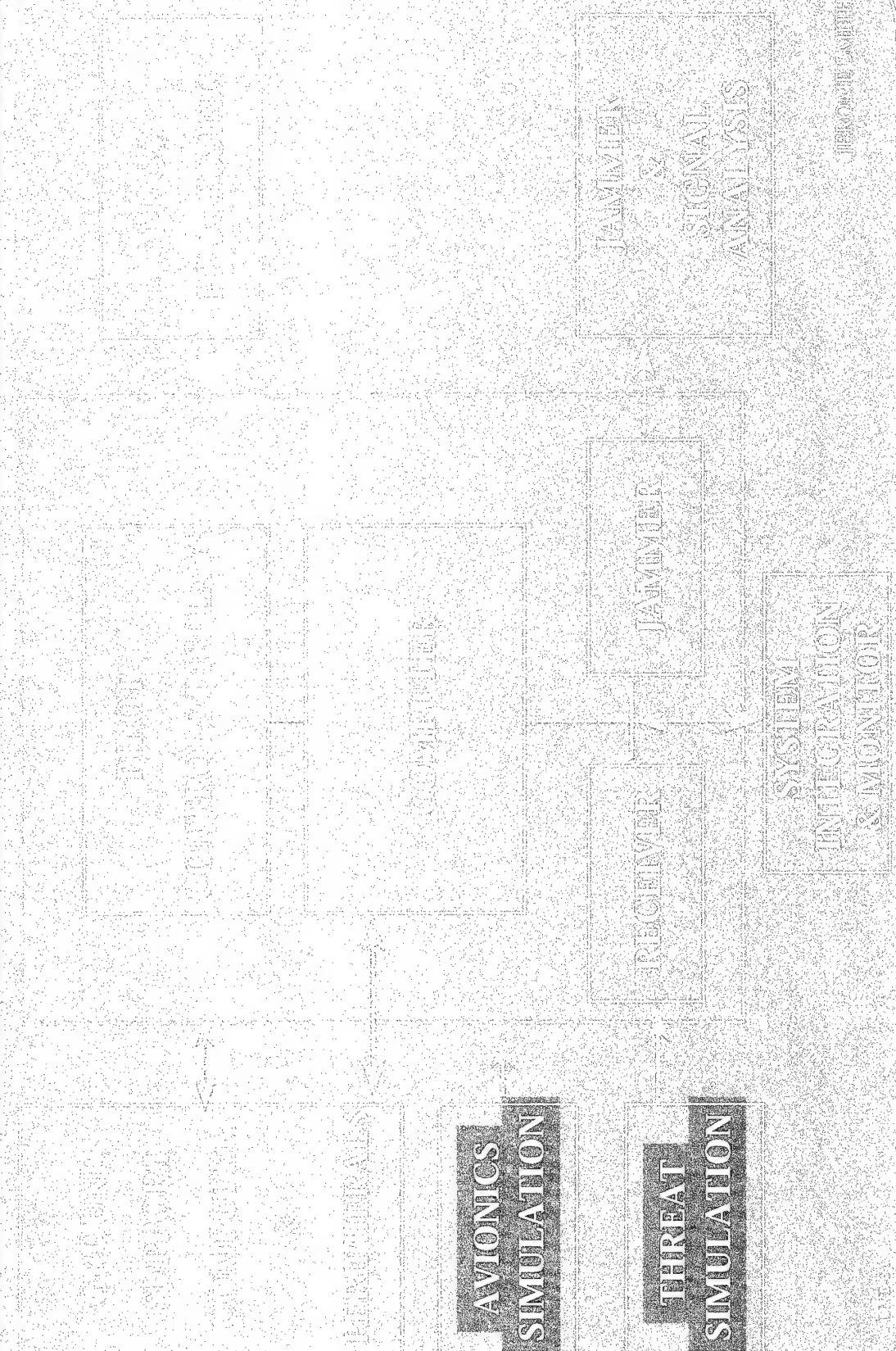
DEFINITION

TECHNOLOGY

- SIMULATORS
- DATABASE TOOLS
- “AUTOMATION”

EWAISF

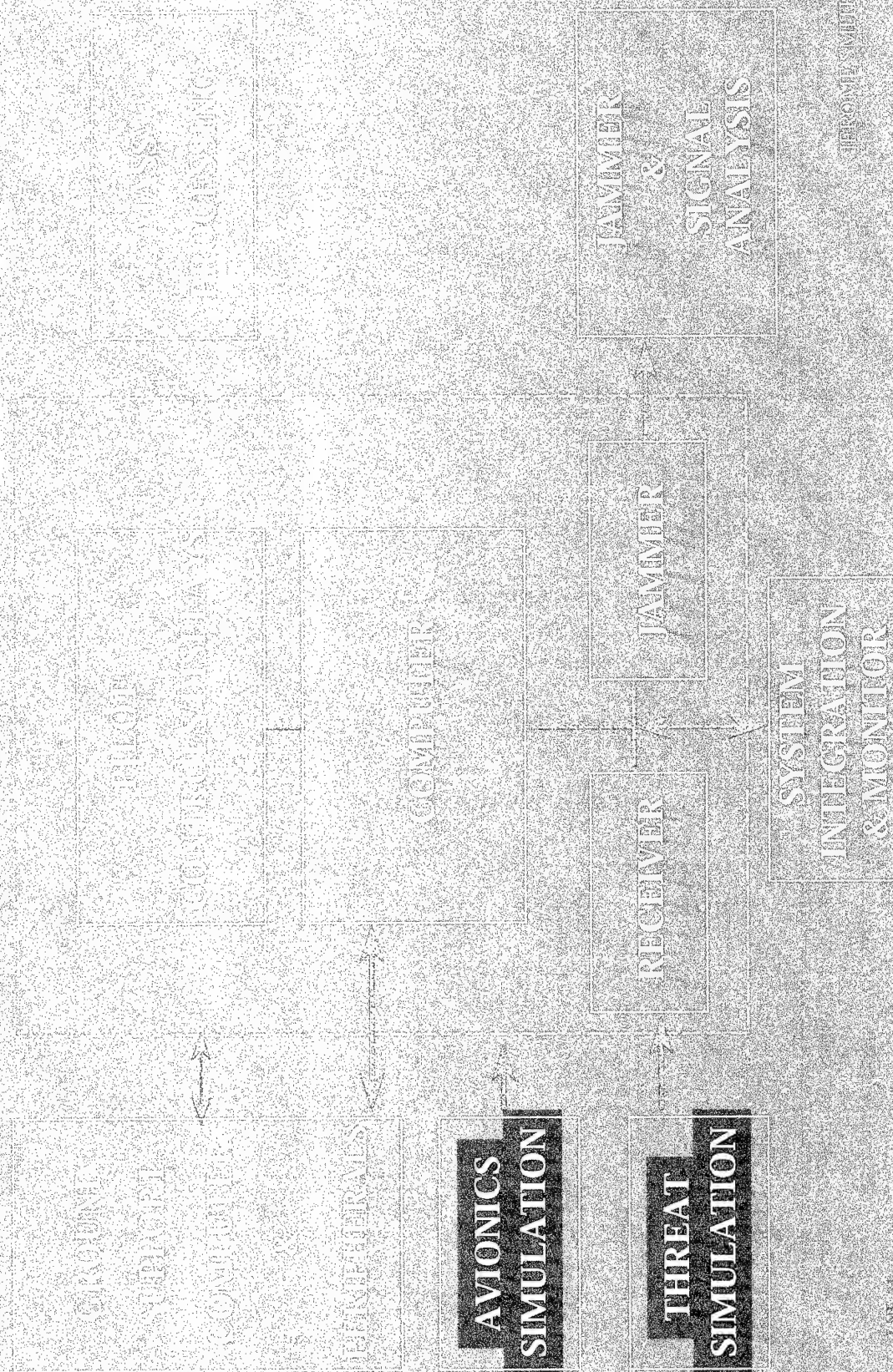
Integration Support Station (ISS)



PERFORMANCE

EWAISF

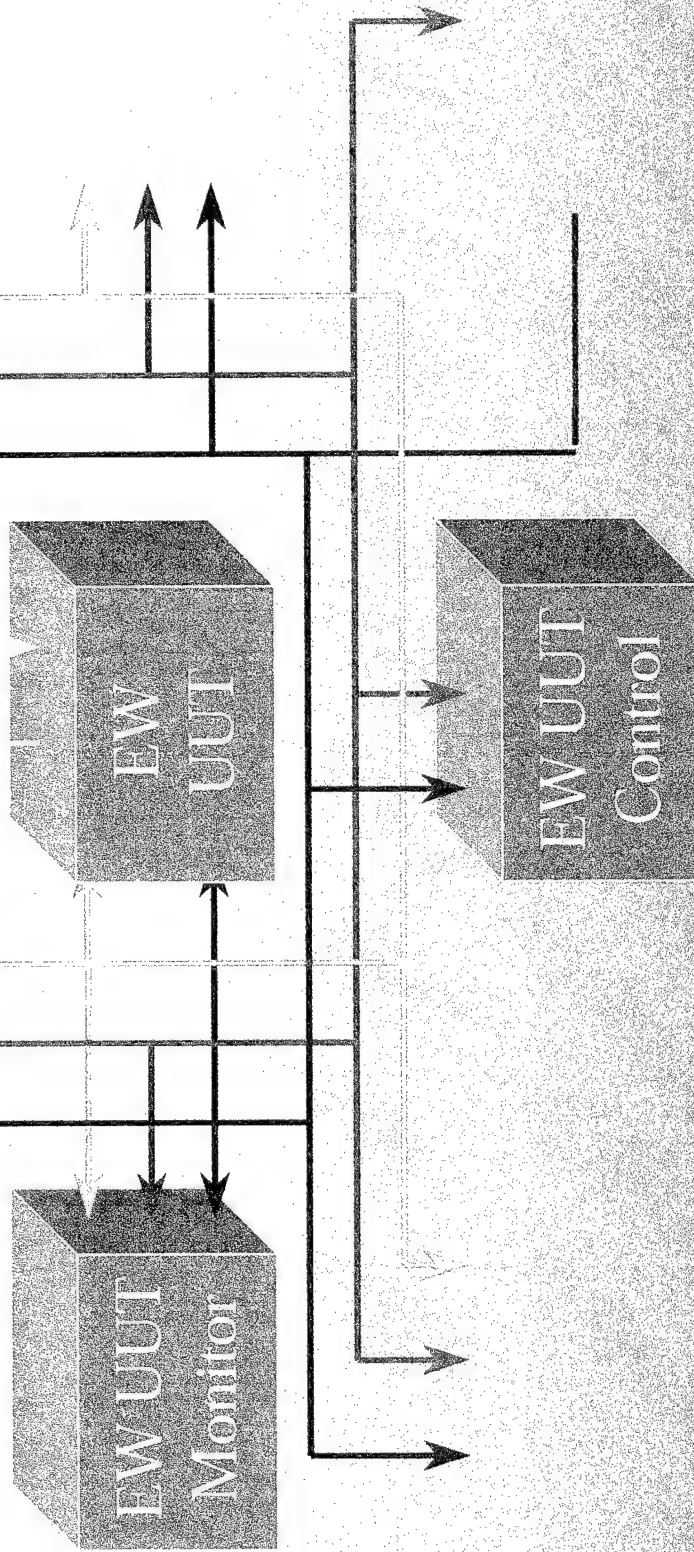
Integration Support Station (ISS)



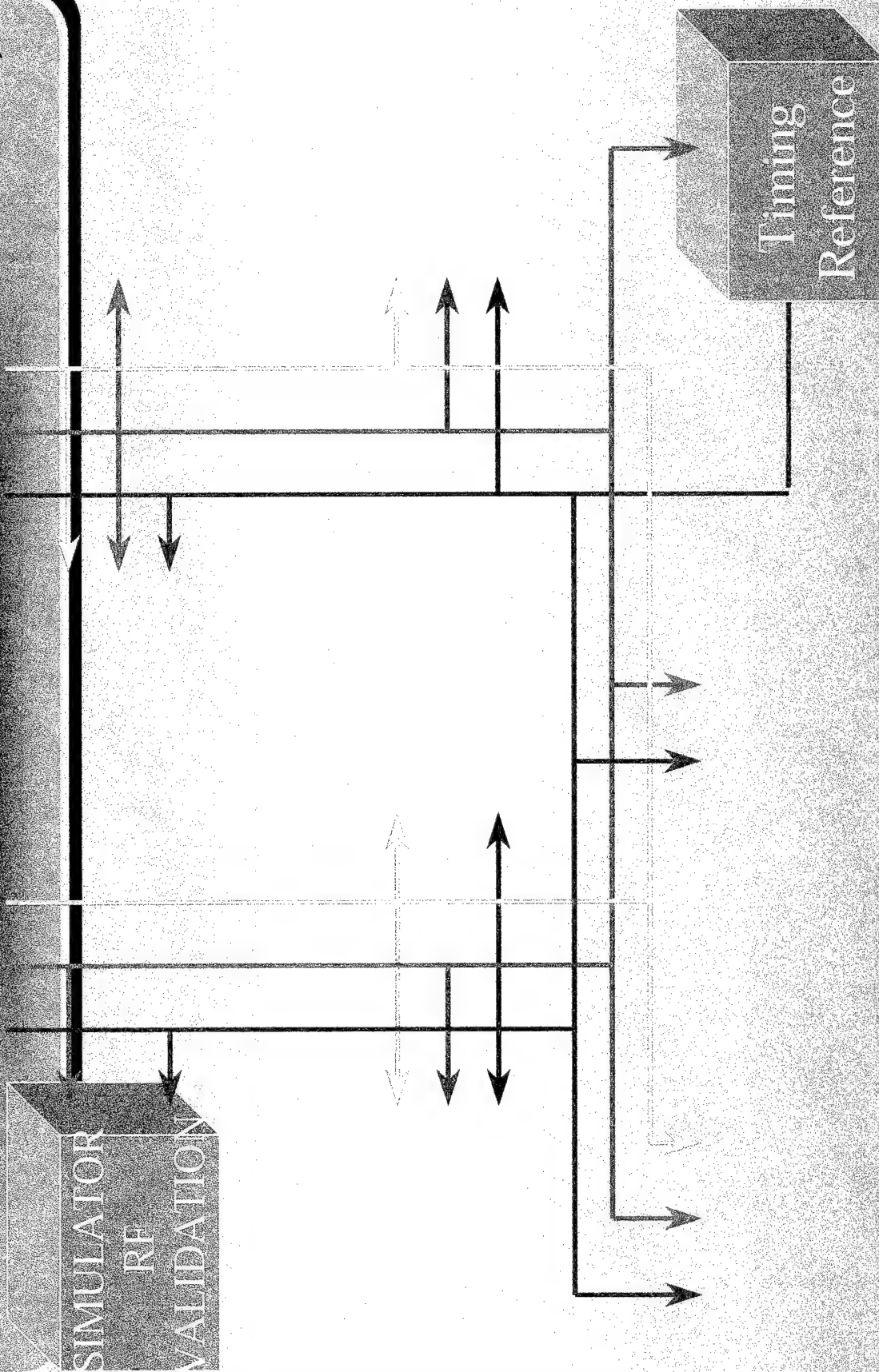
**AVIONICS
SIMULATION**

**THREAT
SIMULATION**

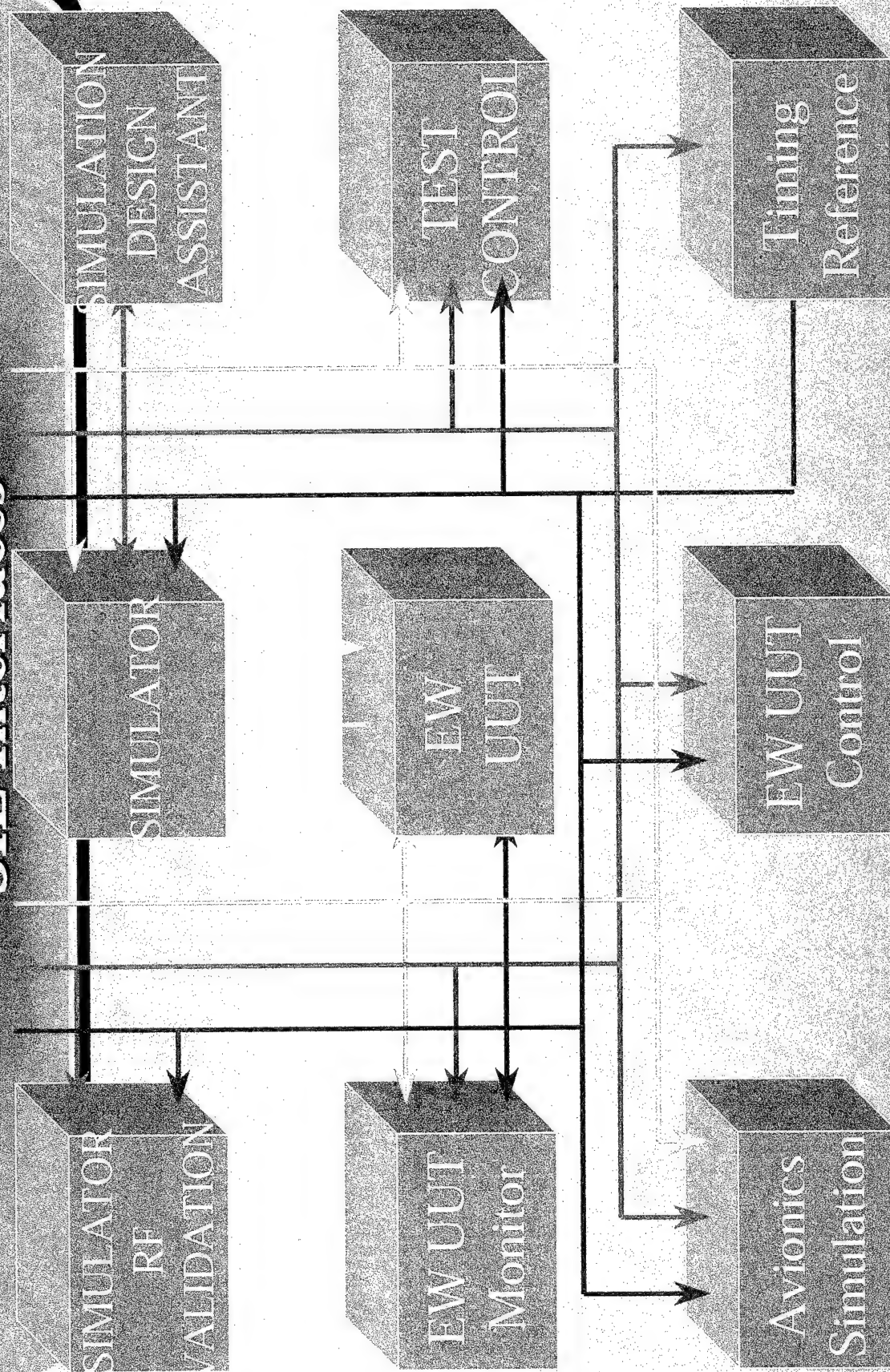
SLL Interfaces (ISS COMPONENTS)



SIL Interfaces (PROCESS MONITORING & CONTROL)



SIL Interfaces



Simulation Basics

signal
simulations

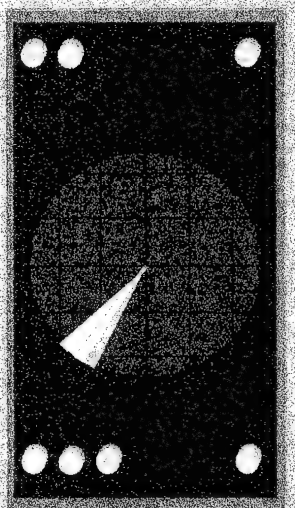
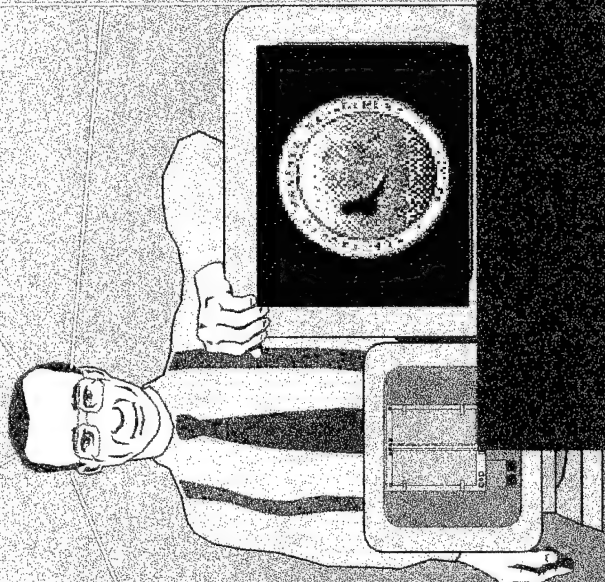
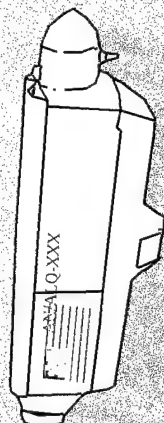
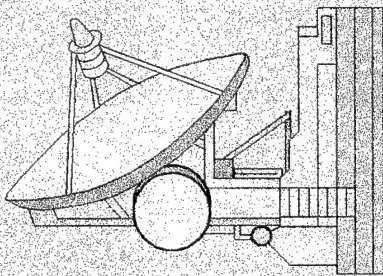
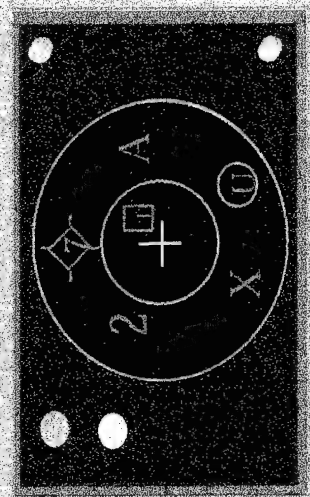
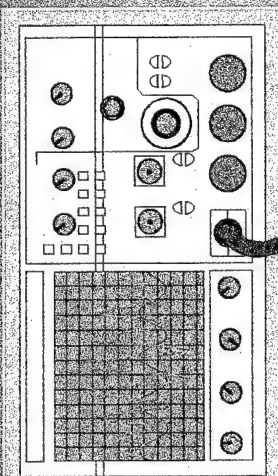
data sources

and
requirements

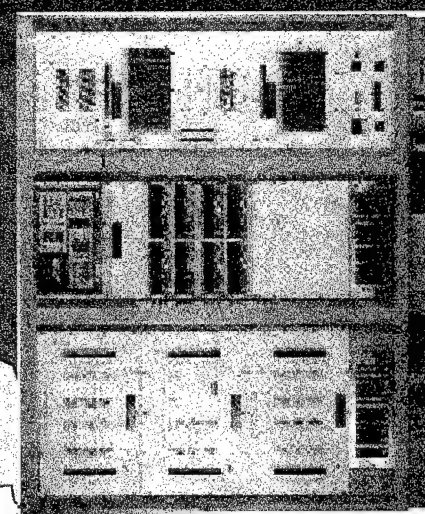
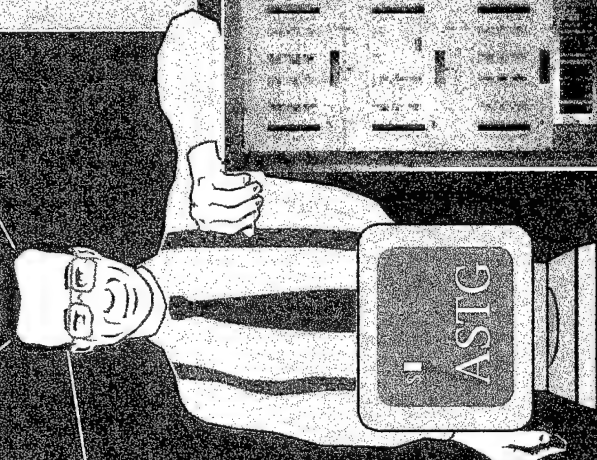
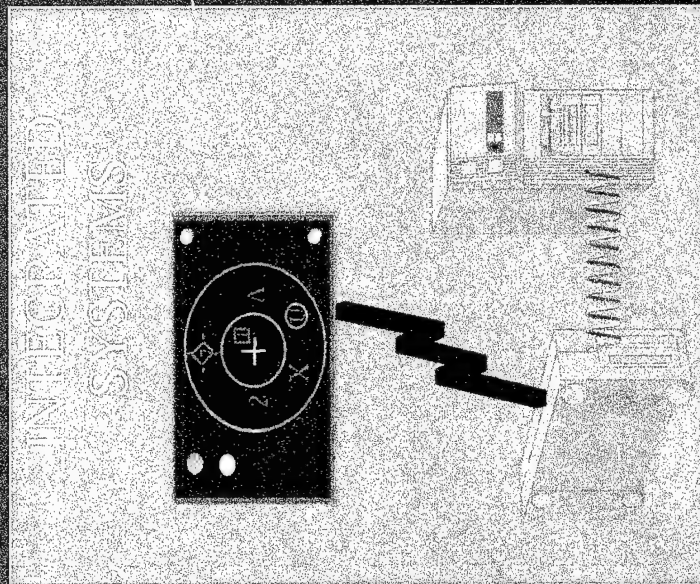
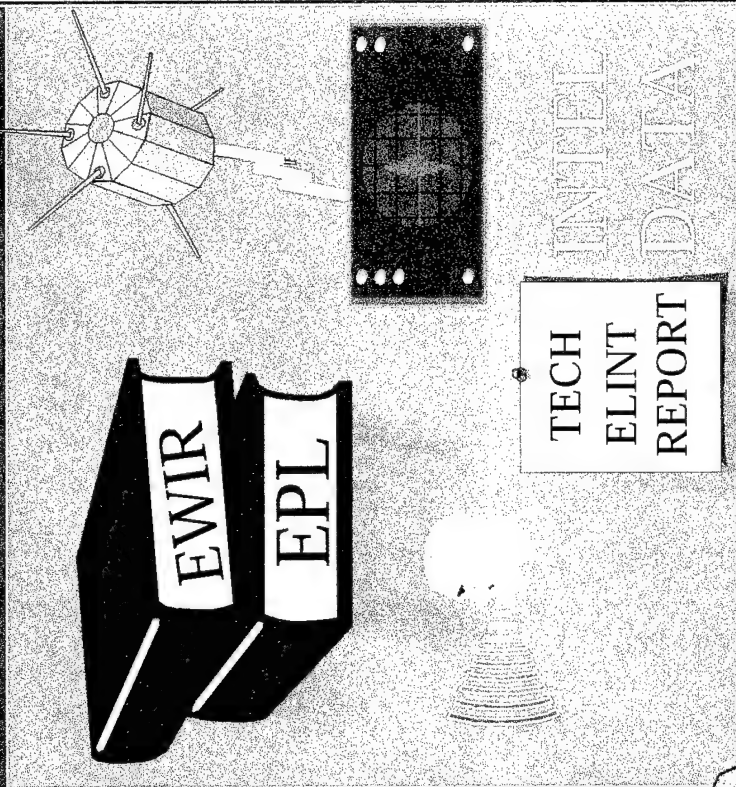
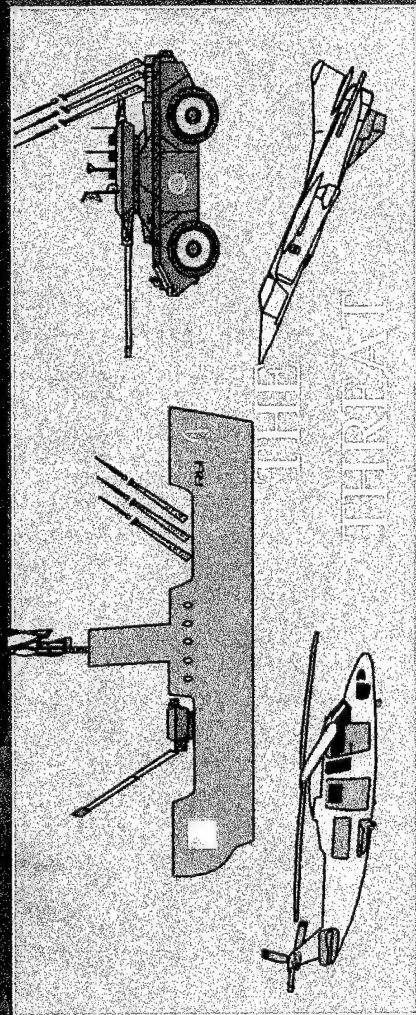
Expert Personnel

JEROME SMITH-39

FACTORS



FACTORS

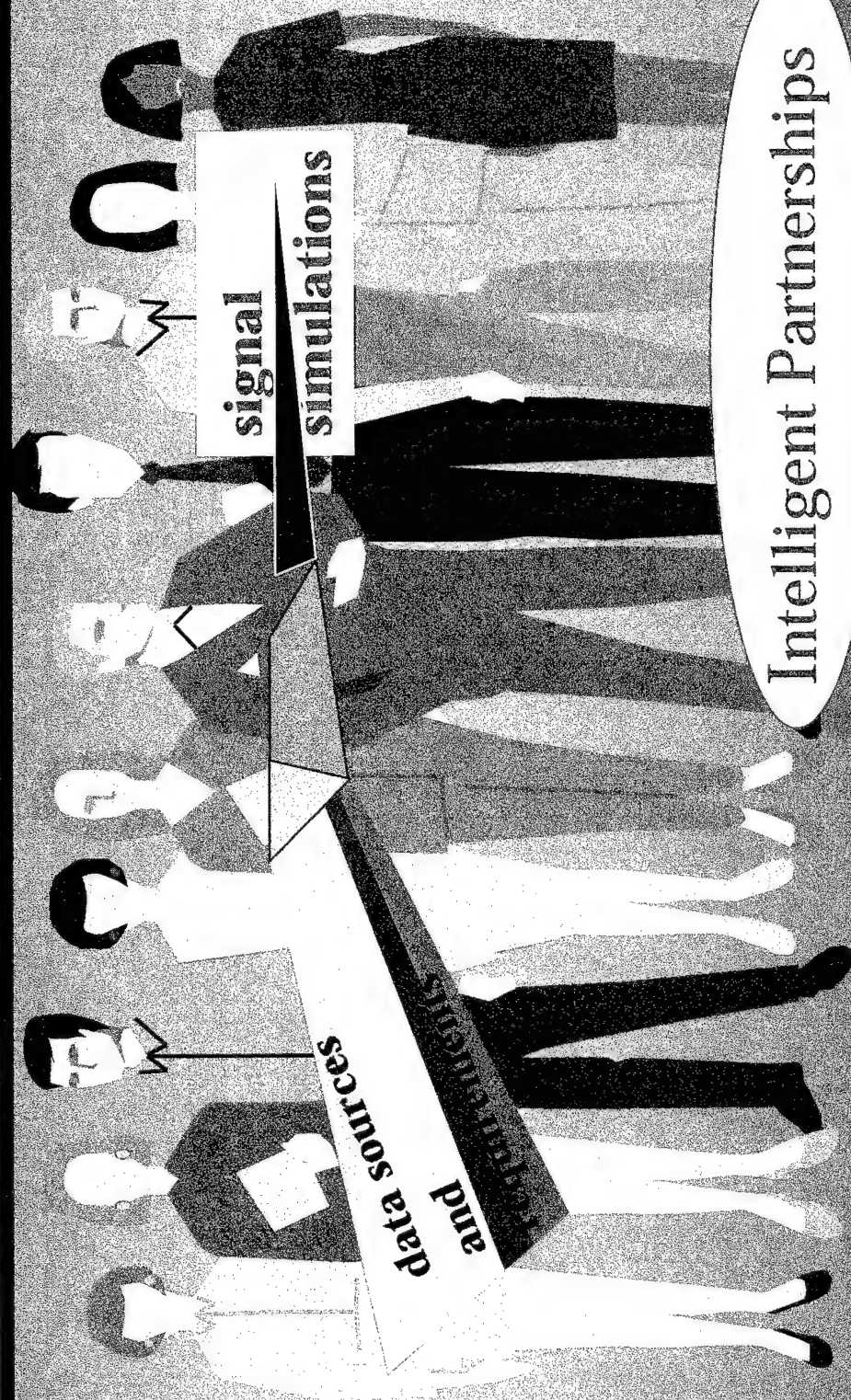


JEROME SMITH-45

LARRY-41

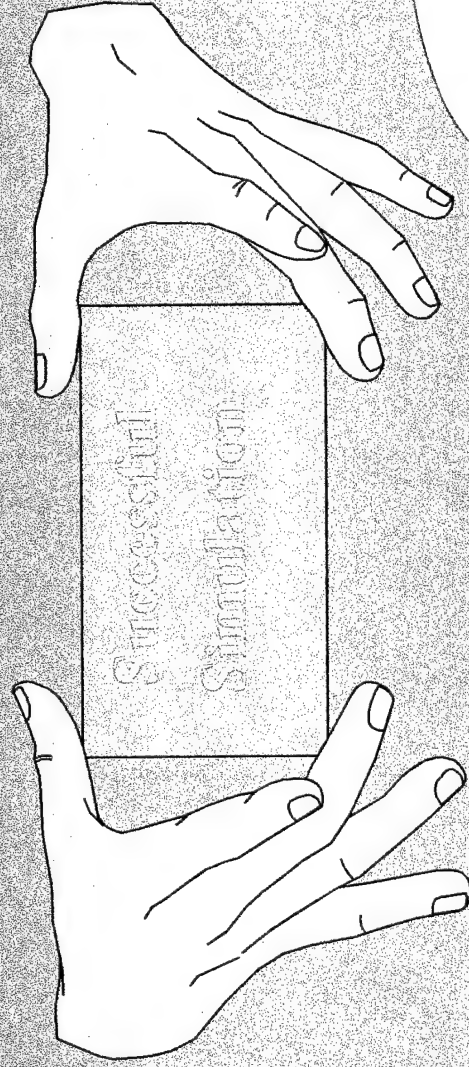
1073

Simulation Basics



JEROME SMITH 46

Simulation Basics



technological tools
&
effective processes

expert personnel

intelligent partnerships

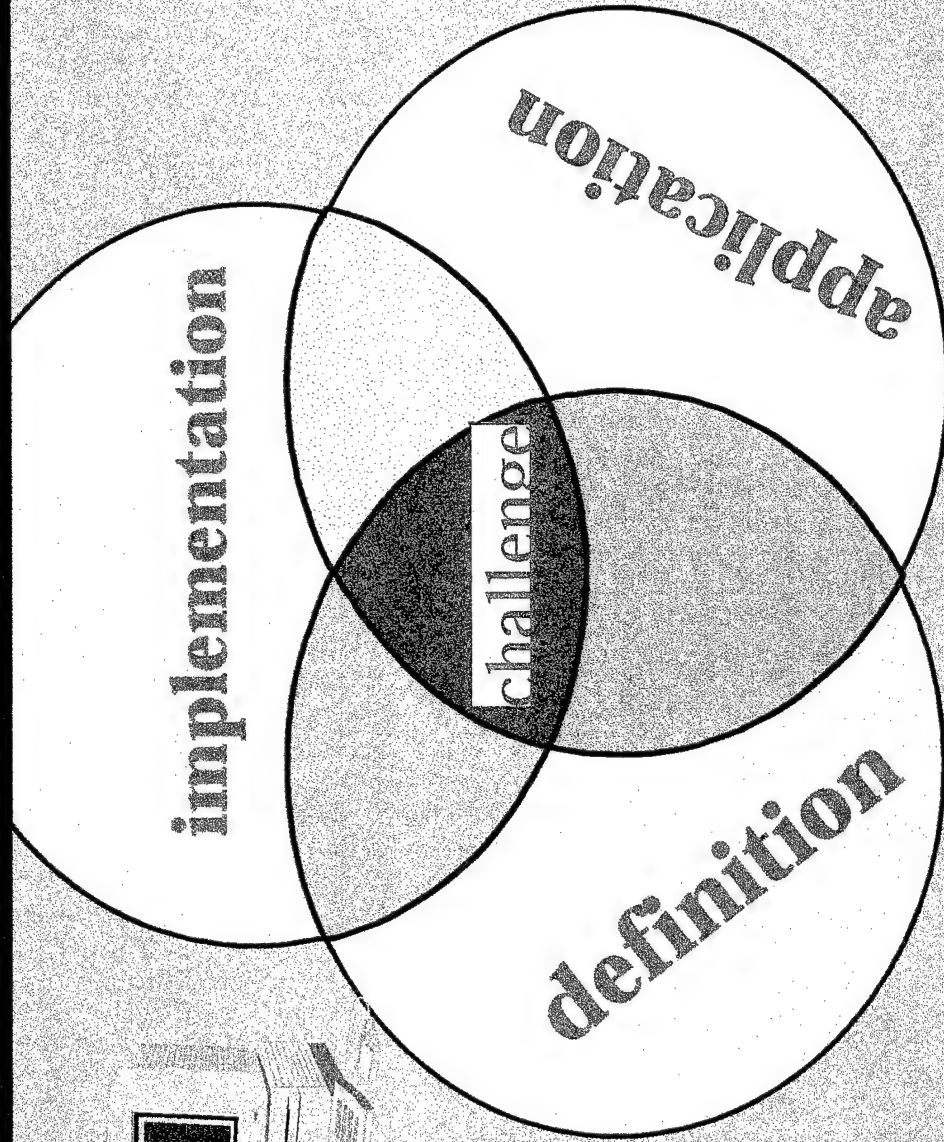
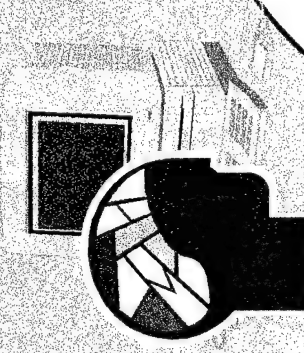
Jerome Smith 47

PEOPLE-PROCESS-TECHNOLOGY

- EXPERTISE plus partners
- methodologies/documentation
- tools

•BALANCE

QUESTIONS?



The **SIMULATION** *CHALLENGE*

- the challenge
- a process of handling the challenge
- technology employed or needed
- process-people-technology relationship

The CHALLENGE

- not unique to System Integration Labs (SILs)
- three aspects: 1) **acquisition of information**
2) **implementation of process**
3) **retention & dissemination**
- Adequate simulation is highly sought after

IDEAL versus Reality

- complete information & requirements
- perfect management, manipulation & use
- right quantity, absolute technical accuracy, and perfect utility
- incomplete & often changing
- cost & resource constraints
- platform variations & capabilities/limitations

The 4 C's

- **Constraints** -- schedule, resource, cost
- **Complexity** -- requirements through dissemination
- **Components** -- expertise, methods, technology tools, partnerships
- **Criticality** -- “prime time” warfighter support

PROCESS

- Definition phase
- Implementation phase
- Application phase

TECHNOLOGY

- SIMULATORS
- DATABASE TOOLS
- “AUTOMATION”

PEOPLE-PROCESS- TECHNOLOGY

- EXPERTISE plus partners
- methodologies/documentation
- tools

•BALANCE

The SOS Track

- **Wednesday afternoon thru Friday Morning**
- **Concurrent OBSCURANT Track**
- **Thursday**
- **Program -- spectrum of simulation, mission environments, and T&E**

SIMULATION Working Group

Session

- Informal discussion
- Issue Identification
- Possible Solutions
- **SIMULATION & SENSOR CHALLENGES**
- **CHANGING SUPPORT CONCEPTS**

ISSUE

- Support concepts -- **What is known about “latest” initiatives and whom?**
Policy makers, developers, implementers, intended users, testers, acquisition decision makers

ISSUE

- **SIMULATION development**
- **SIMULATION follow-on support**
- **Rapid reprogramming of simulation in T&E and training / mission rehearsal**

ISSUE

- Simulation/Simulator/Test Tools update:
COTS / legacy / hybrid / open systems

The SIX PILLARS of the Avionics and Weapons Systems Test Process

- **Modeling & Simulation (M&S)**
- System Integration Laboratory (SIL)
- Hardware-in-the-Loop (HITL)
- Installed Systems Test Facility (ISTF)
- Open Air Range (OAR)
- Measurement facility

TEST PROCESS

- **GOALS:** 1) Provide accurate and useful data
- 2) Assist in shortening the acquisition cycle of weapon systems
- 3) Invoke more discipline into the testing
- 4) Make use of technology (M&S)

TEST PROCESS

Decision Steps Evaluation Steps

- Identify required information (step 1)
- Research
- Development & Acquisition activities
- Combine T&E and other assessments (step 5)
- Pre-test analysis (step 2) -- Major objectives & expected results
- Planning & Conduct (step 3) -- measured results
- Post Test Synthesis & Evaluation (step 4) -- feedback

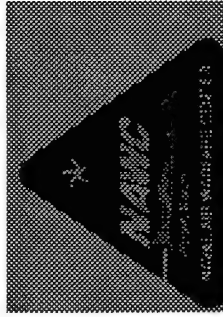
TEST PROCESS

Theory

- Six defined categories of test resources
- Solve acquisition problems through defined PROCESSES & TECHNOLOGY

Implementation

- Reality depends on service interpretation & implementation and fiscal/political factors
- Progress has been made but is complex problem



AIRBORNE ASW ACOUSTIC SENSORS

JOINT SERVICE AVIONICS
BRIEFING TO INDUSTRY

17,18 JUNE 1998

Michael T. Junod

NAWC AD 4.5.5.4.1

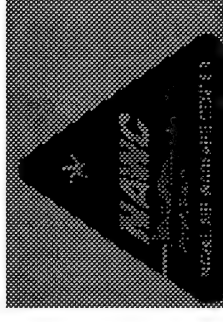
(301)-342-2131

(301)-342-2098 (fax)

junod_michael%pax6a@mr.nawcad.navy.mil

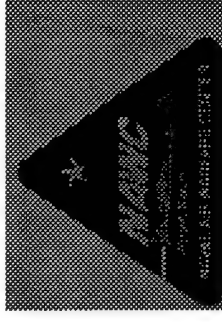
1064

DOD TAP Structure



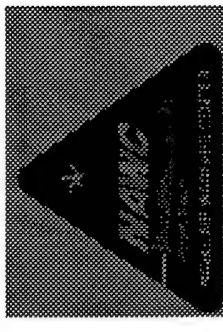
- **Air Platforms**
- **CB Defense and Nuclear**
- **Info Systems and Tech**
- **Ground Vehicles and Watercraft**
- **Materials and Processes**
- **Biomedical**
- **Sensors and Electronics**
- **Space Platforms**
- **Human Systems**
- **Weapons**

Sensors, Electronics, and Battlespace Environment TAP Structure



- **Radar Sensors**
- **Electro-Optic Sensors**
- **Acoustic Sensors**
- **Automatic Target Recognition**
- **Integrated Platform Electronics**
- **RF Components**
- **Electro-Optics Technology**
- **Microelectronics**
- **Electronic Materials**
- **Electronics Integration Technology**
- **Terrestrial Environment**
- **Ocean Battlespace Environment**
- **Lower Atmosphere Environment**
- **Space / Upper Atmosphere Environment**

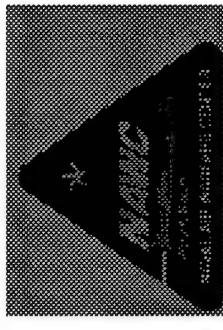
Acoustic, Magnetic, & Seismic (AM&S) Sensors Scope



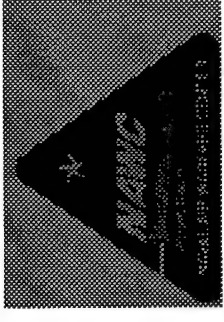
- **Develop Acoustic, Magnetic, and Seismic Sensor Technologies To:**

- Detect, Classify, Track, and Localize Targets in the Battlespace
 - » increase resolution and dynamic range
 - » improve target detection and classification in cluttered environments
 - » classify and localize faster and more accurately
- Decrease sensor volume and weight
- Improve affordability

Why Air ASW



- Air has a Major Role in ASW
 - Global Rapid Response
 - Flexible and Adaptable to Changing Tasking
 - Highest Search Rate
 - Multi-Mission ASW (Surveillance to Attack)
 - Operates “Out of the Submarine’s Sphere of Influence”
 - Joint or Independent OPS
 - Exploits Multiple Phenomenology
- New S&T Important to Optimize Air ASW Capabilities



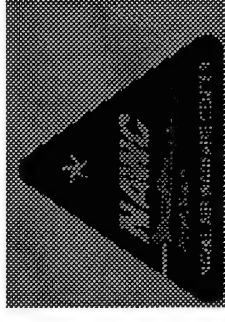
Key Littoral ASW Needs

- Survivable, reliable, joint-capable C4I system architecture
- Detailed and thorough knowledge of battlespace environment
- Cueing sensors that can provide rapid initial detection anywhere in a large area
- Increased reliance on active sonar, multi-static active systems, and non-acoustic sensors
- Detection and localization sensors that enable successful prosecution
- Diversified portfolio of assets that provide rapid and continuous response to threats
- Weapons that can deliver a rapid, decisive response

REFERENCES:

1. Littoral anti-submarine warfare concept, naval doctrine command, 16 June 1997
2. 1997 ASW focus statement, OPNAV
3. 1997 ASW assessment, OPNAV N84, 10 April 1997
4. 1997 Science and technology requirements, N091 & ONR, 31 July 1997

Collocation of ASW Assets

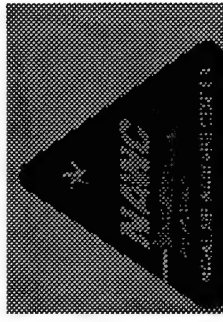


Need Picture

“ASW Alley”

- VX-1 Operational Test & Tactics Development
- Platform & Sensor Development Test Teams
- Sensor S&T Research and Development Teams
- TSC Life Cycle Support
- METOC
- PEO (A) Acquisition Teams
- So. Lab Complex (1.0 mil)

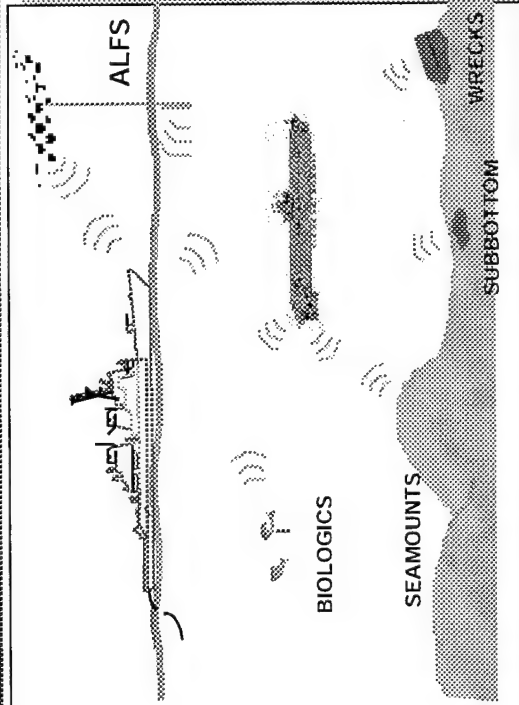
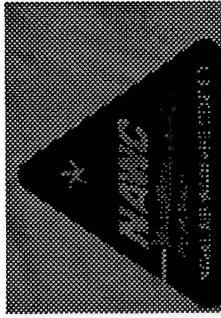
Air ASW Acoustic Sensors 6.2 Programs



- **AACD
(ALFS Active Classification Development)**
- **Environmentally Adaptive Active Classification for
Impulsive Source Sonars**
- **Airborne Rapidly Deployable Technology**
- **PADS (Parametric Airborne Dipping Sonar)**
- **Air ASW Surveillance**

AACD

(ALFS Active Classification Development)



NAVY NEED

- Improved active detection and classification capability against conventional subs in shallow water

PROJECT OBJECTIVE/EXPECTED PAYOFF

- TRANSITION of an Computer automated / operator aided active classification capability (sub / non-sub) for ALFS⁽¹⁾
- Detection of low target strength, low Doppler submarines in high clutter shallow water environments⁽¹⁾
- Frequency band selection for interoperability to prevent mutual interference and enable bistatic operation with AN/SQS-53 and TARS

TECHNICAL ISSUES

- Definition and implementation of interoperability and bistatics
- Collection of sufficient data for tuning and evaluation
- Applicability of algorithms to ALFS sensor
- Similarity of MUF array and ALFS data

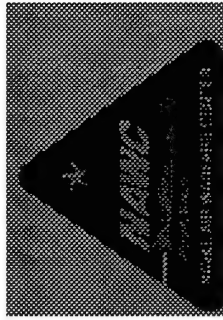
MILESTONES

- FY97
 - Complete ALFS MAST data Interface
 - Build NAWC MAST processor clone
- FY98
 - Collect Significant quantities of ALFS Data
 - Algorithm Applicability Analysis/definitions
 - Implement ALFS functionality in FBL
- FY99
 - Collect ALFS data
 - Tune & evaluate FBL
 - Transition technology to ALFS system sponsor

¹ Operational requirements document for ALFS, ORD No. 295-05-92

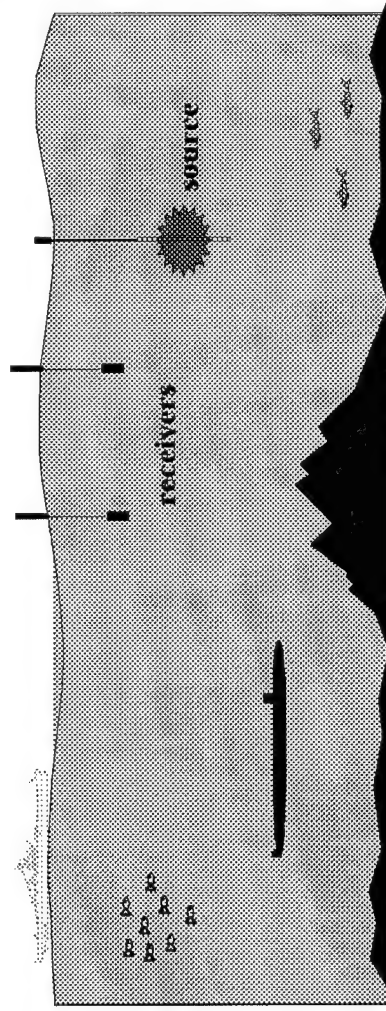
10712

Environmentally Adaptive Active Classification for Impulsive Source Sonars



PROBLEM OVERVIEW

* While limiting the number of clutter detections to an acceptable level, detect and recognize most targets.



ISSUES

- The number of non-target detections per ping, i.e., clutter detections, can be more than a human operator can handle.
- The sources of clutter detections vary from one environment to another.
- The significant effect of ocean propagation on the observed echoes is not well understood and varies considerably from one ocean environment to another.

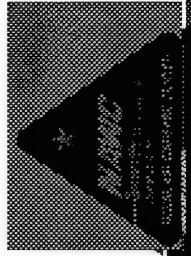
OBJECTIVE

To develop *automatic detection and classification* algorithms that can detect *most* target echoes while limiting the clutter (non-target) detections per ping to a number that the sonar operator can handle.

MILESTONES

- FY97 ■ Characterize *noise* and *signal+noise* waveforms from all available sea tests.
- Extend and interpret real-data observations with acoustic modeling.
- Set energy detector and target-class parameters using historical data and model predictions.
- Develop and test classifier whose clutter parameters are updated after each ping.
- FY98 ■ Investigate several spatio-temporal algorithms for clustering detections.
- Use combination of historical data, *in situ* measurements and modeling to set target-class parameters for classifier.
- Investigate several ways to preprocess detections prior to classification to mitigate medium effects.
- FY99 ■ Determine best overall detector and classifier design, and carefully quantify its performance.

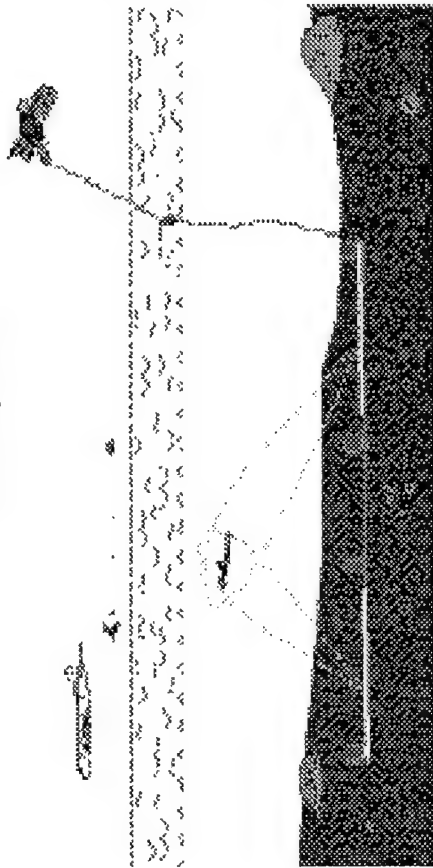
Airborne Rapidly Deployable Technology



NAVAL AIR WARFARE CENTER

AIR DEPLOYABLE SYSTEM CONCEPTS

Air-Launched Glider-Deployed Sensor Systems



OBJECTIVES

- DEVELOP AIRBORNE DELIVERY AND DEPLOYMENT CAPABILITY FOR AUTONOMOUS ASW ARRAYS AND SENSORS IN LITTORAL WATERS

PAYOFFS

- RAPID SURVEILLANCE CAPABILITY IN REMOTE, HOSTILE REGIONAL CONFLICT AREAS
- RAPID DEPLOYMENT (<24 HR RESPONSE, <1 HR DEPLOY, STANDOFF CAPABILITY
- REDUCED AIRCRAFT VULNERABILITY
- FORCE MULTIPLICATION WITH AUTONOMOUS OPERATION

MILESTONES

- FY-96 • SCALE MODEL GLIDER DESIGN/DEVELOPMENT
• RAPID ARRAY DEPLOYMENT TEST/MODEL
- FY-97 • COMPLETE QUARTER-SCALE GLIDER DEVELOPMENT
• INITIATE FULL-SCALE PROTOTYPE DEVELOPMENT
- FY-98 • FULL-SCALE PROTOTYPE GLIDER DEVELOPMENT
- FY-99 • GLIDER PROTOTYPE FLIGHT TEST
• GLIDER DEPLOYMENT OF TEST ARRAY
- FY-00 • FULLY INSTRUMENTED ARRAY COMPLETE
• DEMONSTRATION TEST OF GLIDER AND INSTRUMENTED ARRAY AT SEA

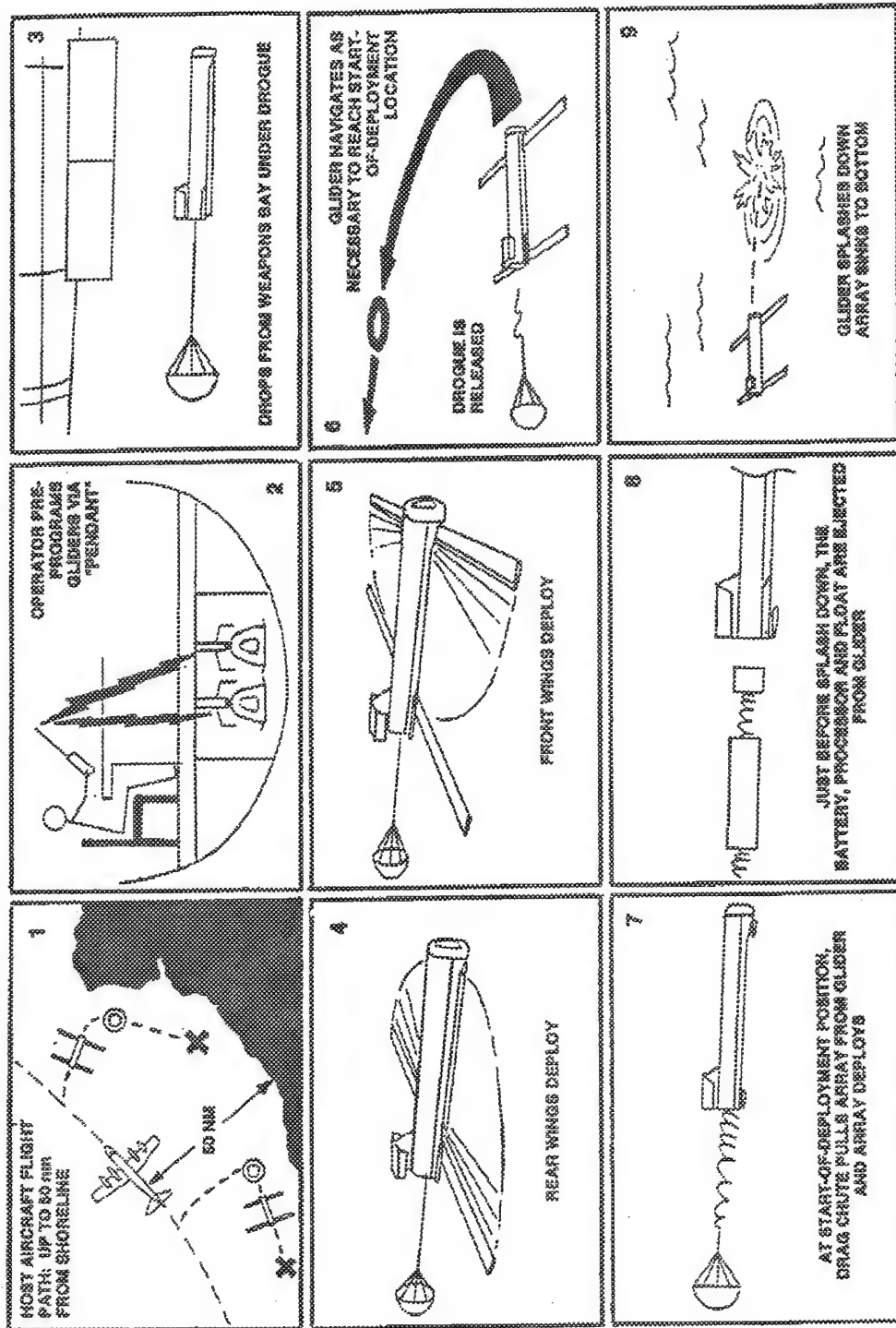
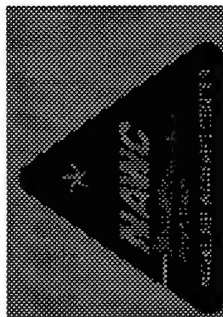
ISSUES

- COMMANDABLE GPS GUIDANCE
- ARRAY DEPLOYMENT GEOMETRY
- COMPACT LOW POWER, HIGH PERFORMANCE FIBER OPTIC NETWORK ARRAY DESIGN

TRANSITION

- ADVANCED DEPLOYABLE SYSTEM (ADS)
- MERLIN, SONOBUOYS, OTHER ASW SENSORS
- OCEANOGRAPHIC SENSORS

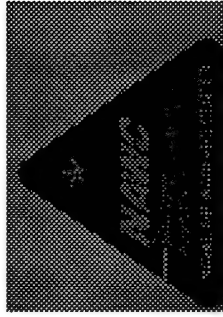
X - Glider Deployment Sequence



FULL SCALE PAYLOAD

WEIGHT - 250 LBS LENGTH - 100 IN DIAMETER - 11.25 IN

Air ASW Surveillance



- **New ONR Sponsored Initiative**

- Four year effort to develop in-buoy signal processing technologies that allow wide area acoustic undersea surveillance and search from air-deployed drifting sonobuoys/arrays

- **Initial Approach**

- In-Buoy processing for advanced ADAR or HLA
 - » Active multistatic automatic detection and classification
 - » incoherent and coherent sources

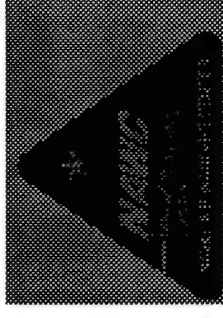
- **BAA**

- Announcement in CBD by next week
- 2 phase development
 - » Phase 1 - four month feasibility phase
 - » Phase 2 - two to four year execution phase
- 5 to 10 page proposals due 31 July
- Finalists will be invited to workshop @ Pax to brief proposals
- Awardees will be selected after Workshop - Work to Begin 1 Oct 98

- **POC**

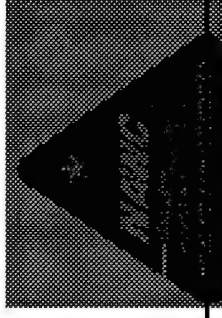
- Dr David Bromley, NAWC AD 4.5.5.4.1
- (301)-342-2116; bromleydw%am7@mr.nawcad.navy.mil

Air ASW Acoustic Sensors 6.3+ Programs



- **LWAD (Littoral Water Advanced Development)**
- **ALFS (Advanced Low Frequency Sonar)**
- **NetTORP (Networked Torpedo)**
- **Distant Thunder**
- **EER/IEER/AEER (Extended Echo Ranging, Improved, Advanced)**
- **SWALAS (Shallow Water ASW Localization and Attack System)**

LWAD



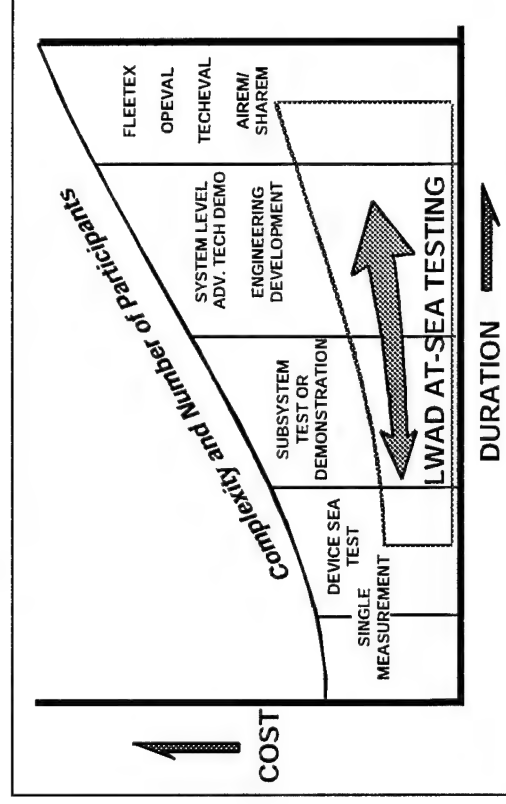
Mission

Provide an affordable sea test program in littoral environments that will enable the transition of advanced USW technologies to higher acquisition category programs.

Project Objectives

- Focus on the littoral undersea battlespace
- Address prioritized fleet and technical issues
- Break across traditional organizational barriers
- Target S&T emerging and operational systems
- Optimize use of people, funds, and assets
- Risk Reduction as identified by customers
- Commit to the transition

Spectrum of At-Sea Testing



Special Features

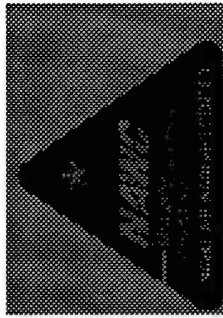
- Experienced Core Sea Test Team (7 Sea Tests/40 projects/2.5 years)
- Direct access to Laboratory, Academic and Industry research assets
- Cross-platform sea test integration

Advisory Board Members

Organization Codes

ONR	32
CNO	N096, N84, N85, N86, N87, N88, N911
DASN	M/UW
DARPA	TTO
NAVSEA	PMS 403, PMS 411, PMS 425, ASTO
NAVAIR	PMA 264, PMA 290, PMA 299
SPAWAR	PD18

LWAD



LWAD PROCESS

Notional At-Sea Testing Scenarios

- I USW Systems Interoperability
- II Tactical Exploitation of the Littoral Environment
- III Advanced Active Sensors
- VI Advanced Passive Sensors
- V Detection of Mines, Obstacles, and Minisubs in the Littoral Environment
- VI Non-Acoustic USW
- VII Network Centric USW

Participants Provide

- Funded programs with well-defined S&T product needing to be tested at sea
- Sea Test Plan inputs and participation
- Funded analysis plan
- Mobilization and demobilization support
- Environmental compliance documentation (if required)
- PI at sea

LWAD Provides

- Research platforms (air, surface, subsurface)
- Fleet asset scheduling (TEIN K1525)
- Environmental characterization
- Integrated sea test planning process
- Mobilization and demobilization oversight
- Chief Scientist, Test Director and Unit Coordinators execute the sea test
- *In situ* data collection for test reconstruction
- Marine Mammal Mitigation procedures for environmental compliance

Products/Deliverables

LWAD

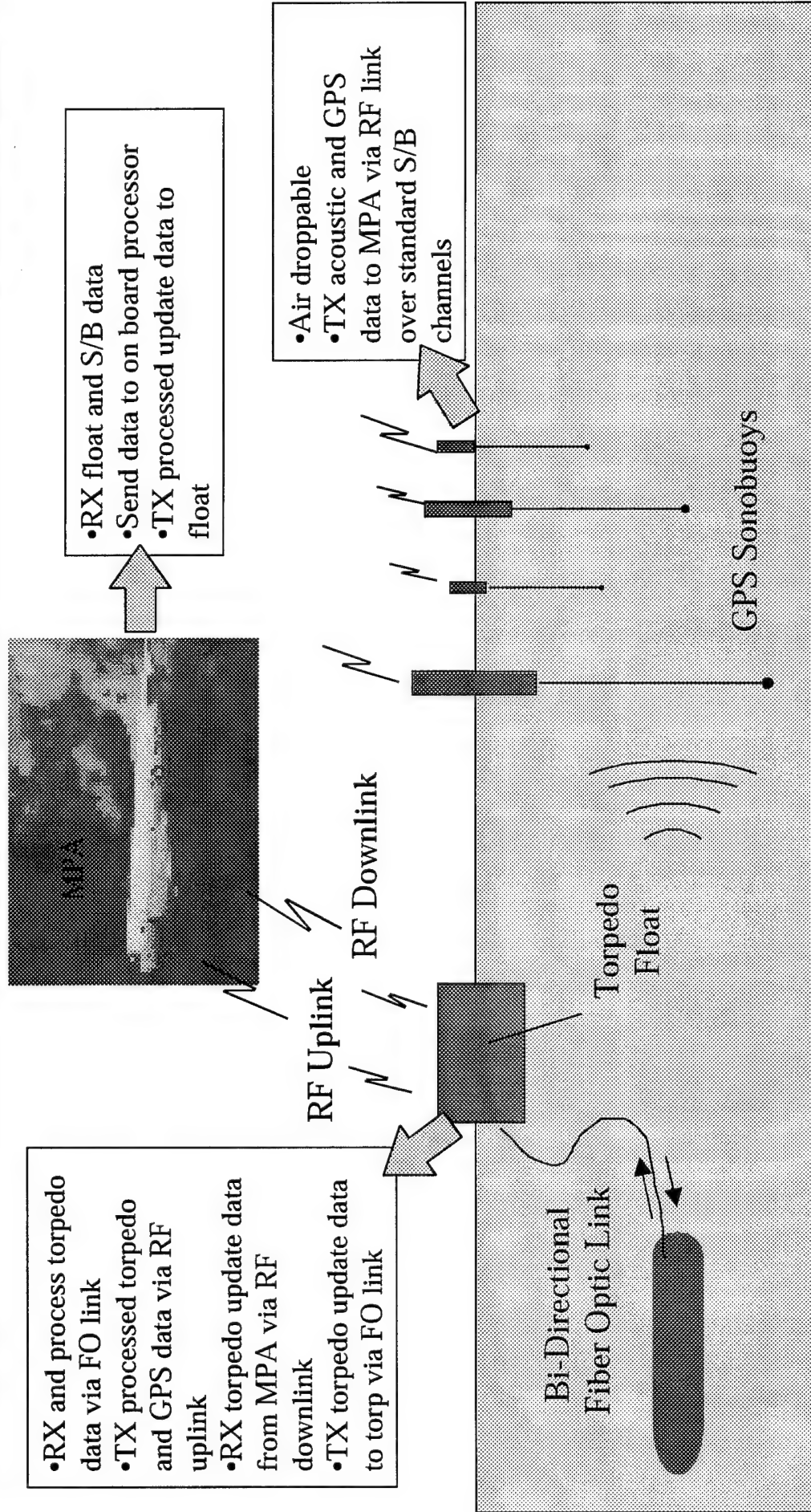
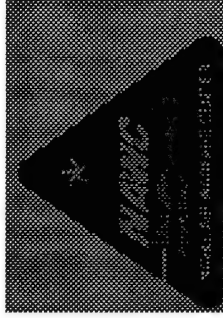
- Environmental Characterizations
- Integrated Sea Test Plan
- Test Reconstruction Dataset
- Quicklook Report (30 days)
- Sea Test Summary Report (8 months)

Participants

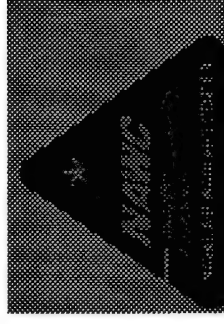
- Quicklook Report (input)
- Sea Test Summary Report (input)
- Technical analysis report/dataset/algorithm



NetTORP (Networked Torpedo)



Air Acoustic Active Systems



SEARCH

EER

IEER

AEER

Operating Areas

Deep

Deep/Shallow

Deep/Shallow

Lead Platform

P-3

S-3

P-3

Source

110 (A) (B)

110(A) (B)

Electroacoustic

Receiver

SSQ 77B

SSQ 101(ADAR)

SSQ 101(ADAR)

Classifier
(Features)

Seq. Rule Based
(6) -----(7)

MVG
(13)

Under development

Display

Full A-scan

BVT, A-scan

Under development
snippets

Processing

8 Directionals
10 OMNI

4 ADAR Arrays

TBD

LOCALIZATION

SWALAS

Deep/Shallow

P-3

Free Flooded Ring
Projector Array

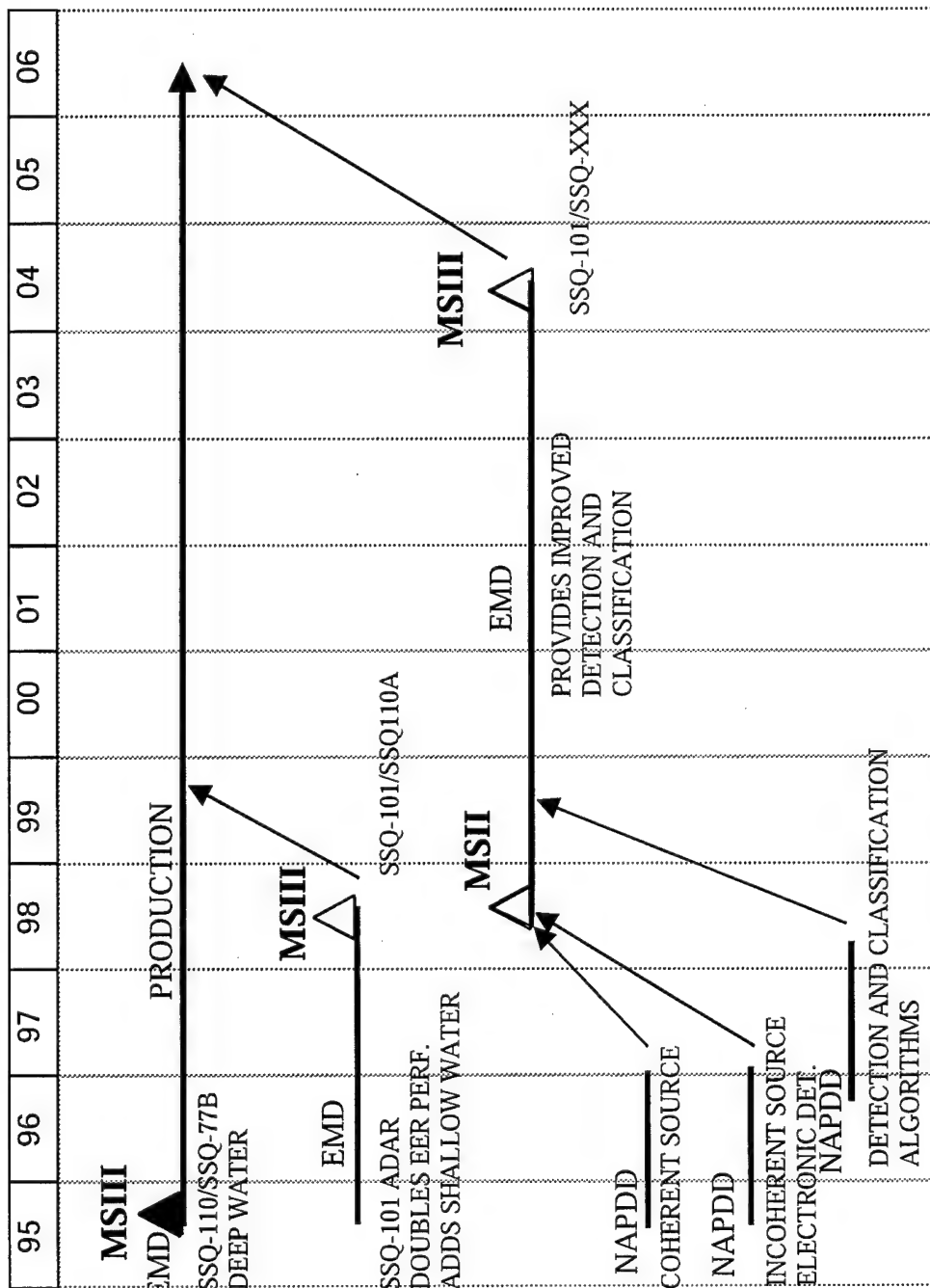
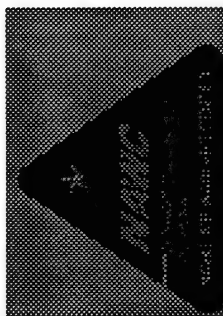
Horizontal Planar Array

TBD

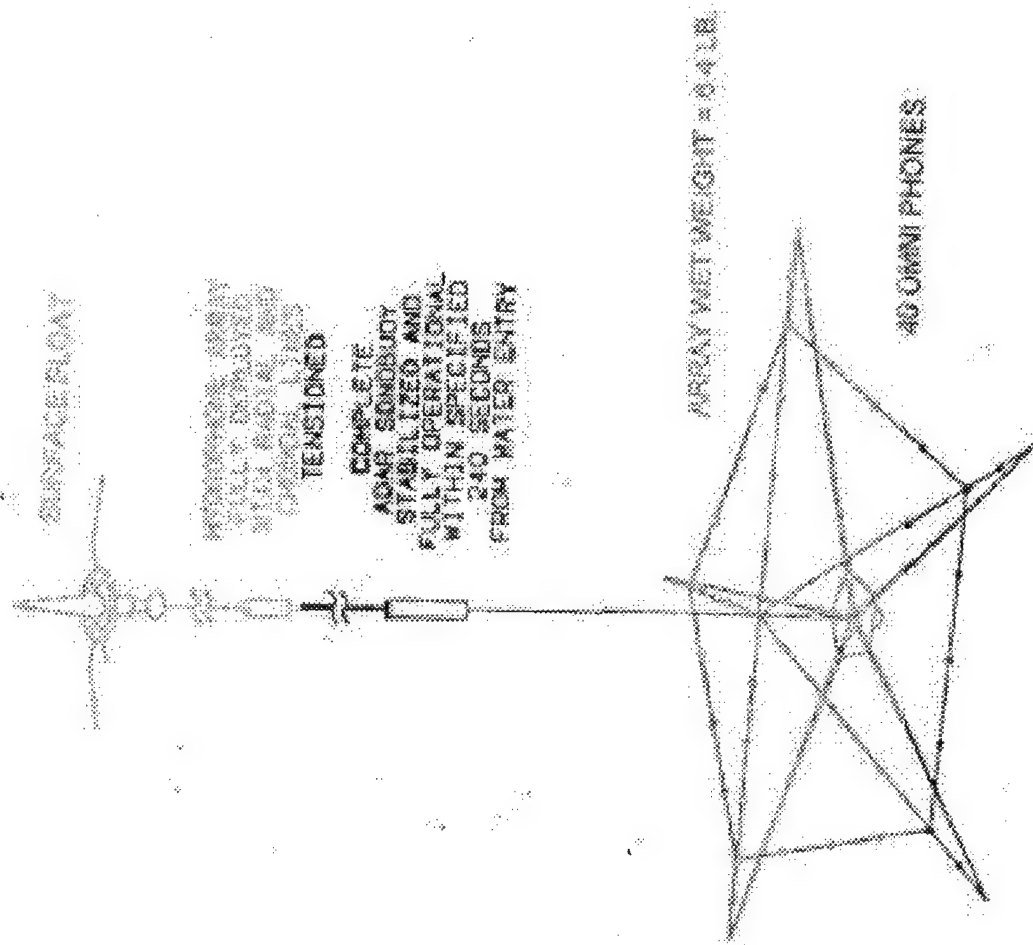
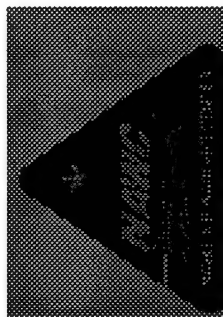
Current DICASS Display

IBSP
(DICASS Compatible)

EER ROAD MAP

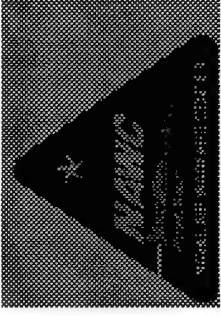


AN/SSQ-101 (ADAR)

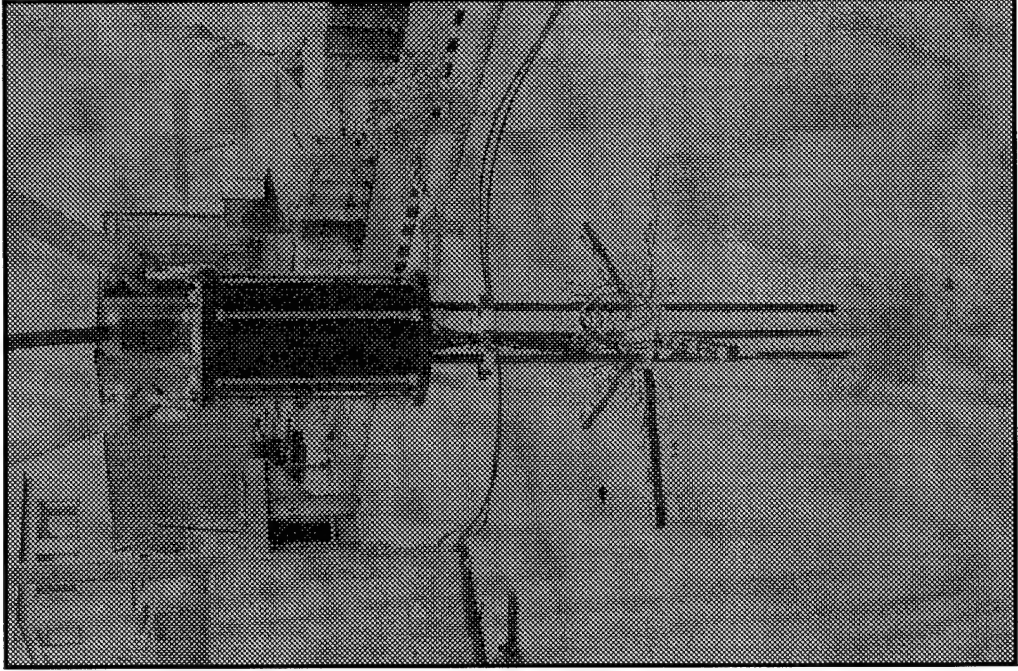
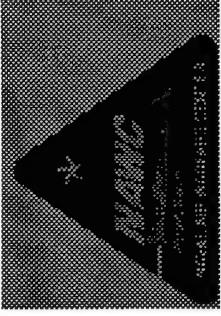


OPERATIONAL DEPTHS = 20, 90, or 160 m

SSQ-101 (ADAR)

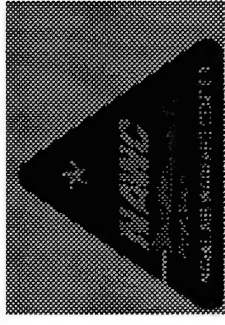


SWALAS Receive Array



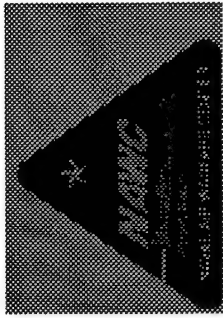
2012

Air ASW In The 21st Century



- Conducted Primarily in the Littorals With Some Deep Water Operation
- Highly Integrated Operations
- Minimal Availability of Traditional Cueing Systems
- Operating Areas will be Inside Contested Waters
- Automation to Offload Operator Workload

Overarching Concepts



Today

- DIFAR
- Extended Echo Ranging (EER)
- Air Deployed Acoustic Receiver (ADAR)
- Laser Radar (LIDAR)
- Low Grazing Angle Periscope Detection Radar (PDR)
- Magnetic Anomaly Detection (MAD)
- Directional Commandable Active Search System (DICASS)

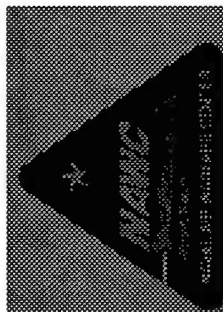
Tomorrow

- AEER
- Shallow Water Airborne Localization and Attack System (SWALAS)
- High Altitude PDR

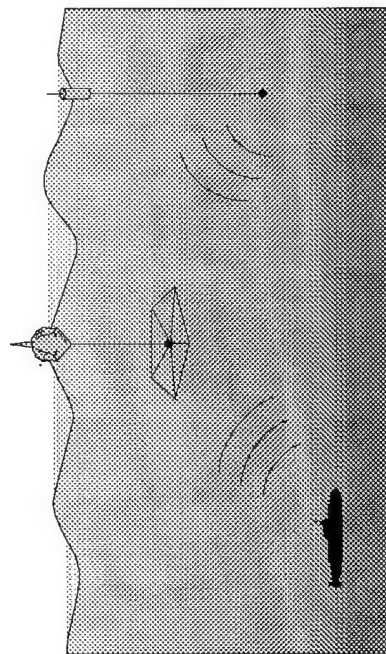
2010

- Long Life Surveillance & Search System
- Ubiquitous multi-statics
- Rapid Automated Battle Space Awareness
- Platform Fully Integrated into Network Centric C4I
- Standoff Using Glide Sensor & UAVs
- Value Added Sensor Phenomenology
- Enhanced Training & Operator Proficiency
- Precision Localization & Attack
- Deep Water Surveillance
- Airborne Rapid Environmental Sensing
- Enhanced System Capabilities using
 - Modularity
 - COTS/NDI
 - Automation

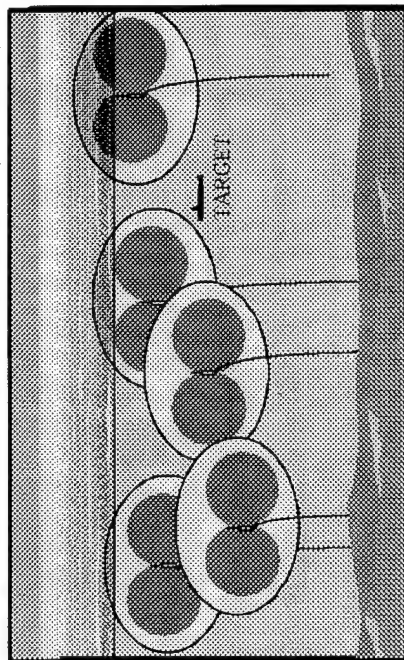
ACOUSTIC R&D TECHNOLOGY CONCEPTS



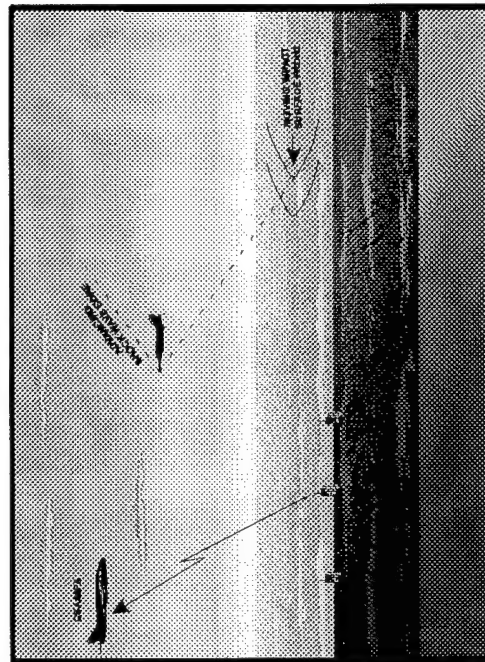
**SMART High Performance
Acoustic Receiver (ADAR+)**



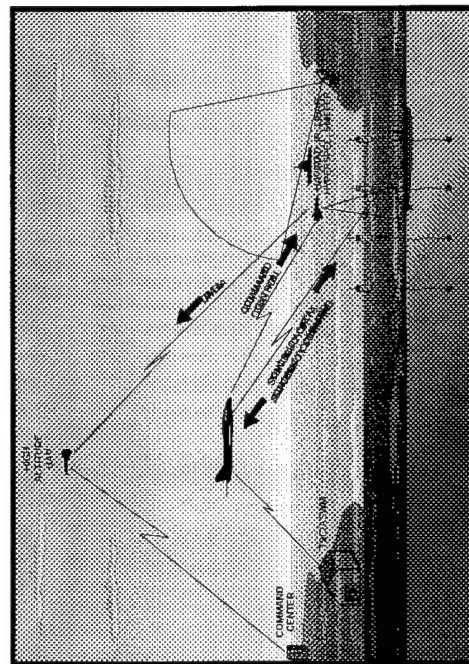
**Shallow Water Deployed
Reconnaissance Multi-Sensor (SWARM)**



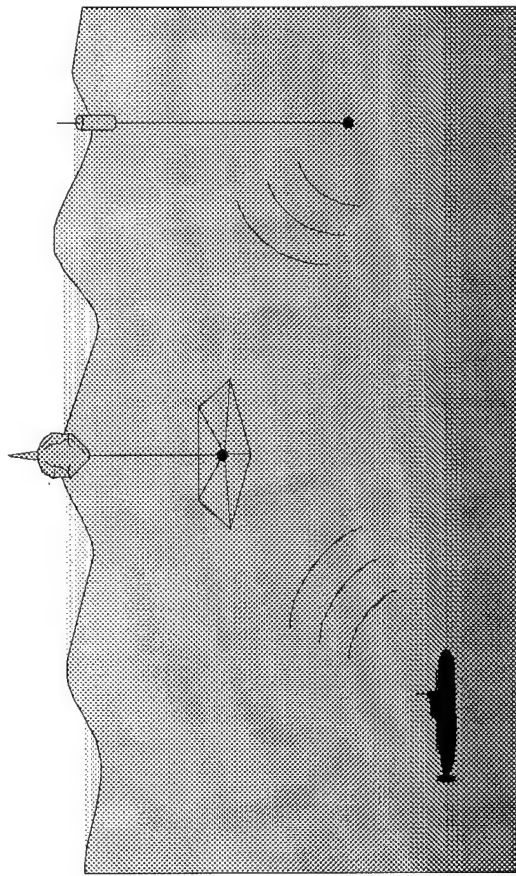
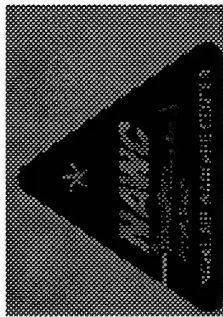
Stand Off ASW



Multi-Sensor ASW UAV



Super ADAR



Features

- GPS
- In Buoy Processing
 - Screeners in Buoy
 - Only Screened Signals Sent to Aircraft
 - Background Passive
 - Screen for C2 Cavitation
 - HF Fathometer
 - LF BB (Planar Array Diffr)
- ABF (SBIR)
- Efficient Digital Code
 - Error Correction
 - Compressed Data
- Command Full Up Direct Ops (Limited BW)/
Command Limited Constant Look Beams

Advantages/Payoffs

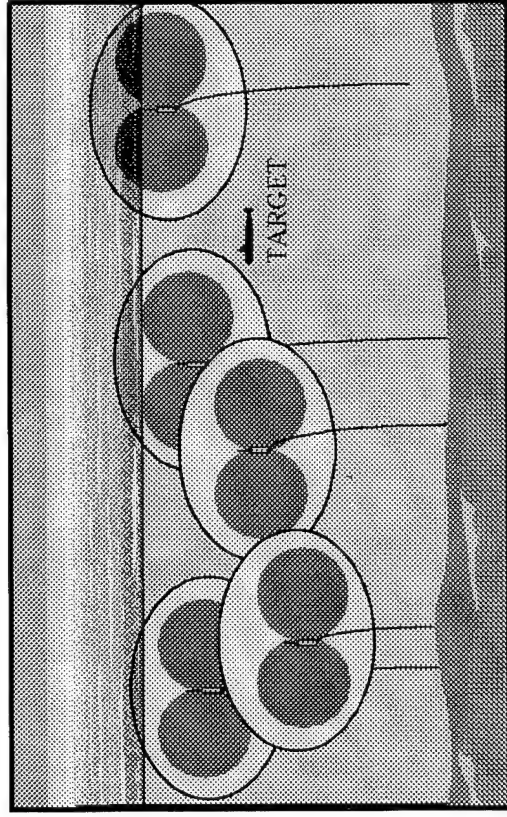
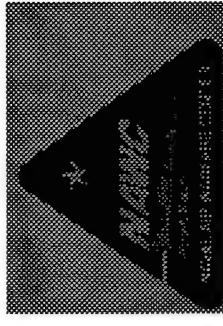
- In Buoy Screeners, Use Full BW
- Full BW Screened Signals Sent to Operator
- Reduced RF BW
- Reduced Transmission Time/Reduced Battery Required
- Reduced Operator Workload

Issues

- Transmit Packet Design
 - Beams? Number?
 - Length of Snippet?
- Screener (Wayland, PBN, Other)
- Background Passive Algorithms
- Adapt Modem Technology to RF Links

10089

Shallow Water Air Deployed Reconnaissance Multisensor (SWARM)



Objectives and Description

- Observe submarine transits over zone
- Covert deployment and operation
- Unattended operation for days or more
- Numerous cheap proximity sensors
- "A" size (can be glided into place)
- Multi-influence confident auto alerts
- Expose & transmit only when triggered

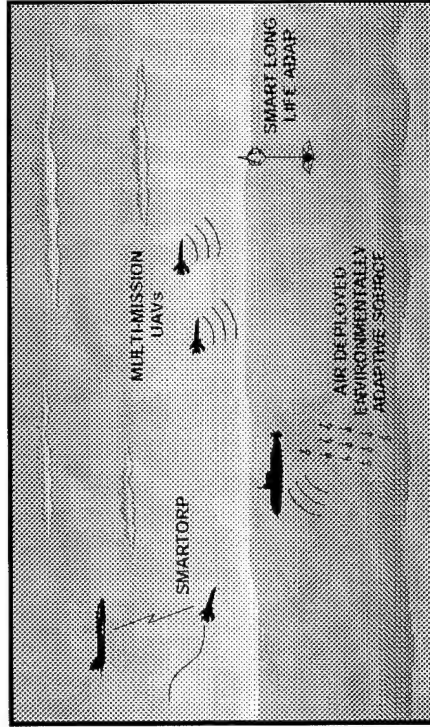
Technologies

- Exploit vertical B vs. horizontal E fields
- Noise, motion & verticality effects
- Ranges, correlations & signatures
- Composite ELFE, Difar with IBSP
- Trial algorithms with reliable features:
 - ELFE, Pressure, C2 & other AIS
- Dual buoyancy bobbing taut line moor
- Field integrity modeling

Advantages and Issues

- Passive except for RF reporting
- Sensors quickly deployable by air
- Near real time reporting; good fixes
- No operator other than tactical viewer
- Provides peacetime or wartime cueing
- Low bandwidth reports easily relayed
- Depth affects bobbing & mooring
- Current affects sensor useful life

Stand Off ASW



Components

- Glide Sensors
- Smart Long Life ADAR
- Air Deployed Long Life, Environmentally Adaptive Active Source
- SMARTORP/NETSTAT
- UAV Mounted Sensors

Technologies

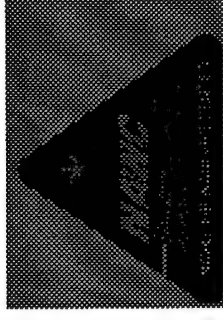
- Data Links
- Data Compression
- Delivery Concepts
- UAV Mounted Sensors
- Stealth/LO UAVs

Issues

- Aircraft On Board Sensor Capabilities
- Low Cost/Lightweight/Low Power Sensors for UAV
 - Radar
 - IR
 - Sniffer
 - MAD
 - Hyperspectrum
- Glider Guidance and Control (Sensor and Weapon)
- UAV Range/Endurance

Air ASW

S&T/R&D Thrusts



Sensors

- Super ADAR
- Shallow Water Air Deployed Reconnaissance Multi-sensor (SWARM)
- High Altitude PDR for Mast & Wake Detection
- Steerable RADAR
- Digital MAD
- Laser & EO Sensors
- Environmental Probes

Processing

- Smart FS
- Universal Adaptive Processor (COTS/MSSIP/PC Spin-offs)
- Autonomous Detection Algorithms & Classification
- Personal Assistant
- Non-Linear Processing
- Neural Nets
- In-Buoy Processing

Sources

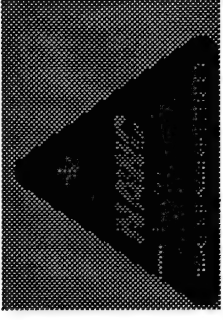
- Long Life Air Deployed Source
- Environmentally Adaptive Directional Source (EADS)
- Supersonic Shock Source (S4)
- Green Source

Sonobuoy Technology

- Deployment Mechanisms
- GLIDE Mechanisms (Strap On)
- GPS/Inertial Tracking System
- Energy Sources (Batteries)
- Efficient Electronics

Air ASW

S&T/R&D Thrusts (Cont'd)

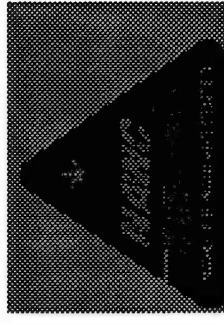


New P³I Platforms

- Multi-Sensor ASW UAV (UAV MAD)
- Uninhabited Combat Air Vehicle (UCAV)
- Common Support Aircraft (CSA)
- ALFS/ADAR

C⁴I

- Multi-Sensor/Platform Information Fusion for ASW (Fuzzy Logic/Correlation)
- Enhanced Telemetry (Data Link & GPS)
- Embedded Training
- Air Launched Real World Training, Stimulation and Simulation

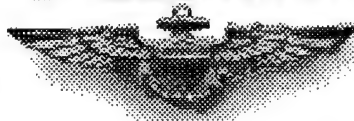


Conclusions

- Air has a Major Role in ASW
- Littoral ASW will drive the direction for new airborne ASW systems development
- NAWC has developed an Air ASW system strategy
- Current ASW situation requires unified approach between platform and sensors supported by strong ASW leadership
- NAWC has initiated focused conceptual approaches
- Revolutionary technology thrusts are required while leveraging off existing system development programs
- Patuxent River complex provides a unique opportunity to facilitate this strategy

NAVAL AVIATION SYSTEMS

TEAM



NAVAL AIR SYSTEMS COMMAND
RESEARCH & ENGINEERING



Software Technology Briefing To Industry

John Walker

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Agenda

- ▲ Changing Roles
- ▲ Current Challenges
- ▲ Sources for Solutions
- ▲ On Going Efforts
- ▲ Summary

Changing Roles

Before, Our Funding Provided Leadership

- ▲ Program office budgets through task leader budgets could accommodate software technology research and insertion
- ▲ All levels of the Organization were funding research into local problems
- ▲ Research was done by organic personnel
- ▲ Small hard problems were solved, Point solutions were developed

Budgets Becoming Smaller and smaller

- ▲ Funding transitioning from Long Term research to Short Terms product focused tasks
- ▲ Funding is controlled at a higher level
- ▲ Technology is being pushed down and across the organization

Now, Our Leadership Will Provide Funding

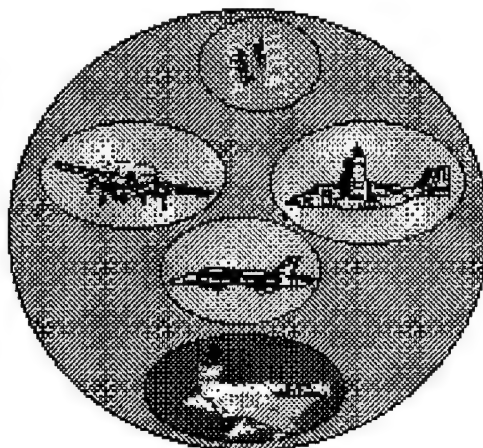
- ▲ Competition for funds is open and fierce
- ▲ Research needs to have a Navy Product Focus
- ▲ Research needs to have broad DoD/Industry Application
- ▲ Solve hard general problems and develop general solutions

Current Challenges

- ▲ **System of Systems**
 - ◆ Network Centric Warfare
- ▲ **Maintenance of Complex Software Systems**
- ▲ **Development of Complex Software Systems**

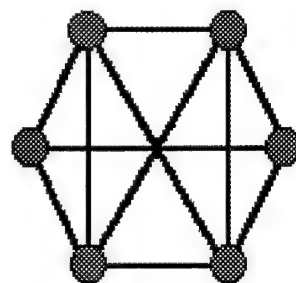
System of Systems

- ▲ **Interdependent**
Systems vary from
platform to code
module in scale
- ▲ **Systems going to**
COTS and GOTS
- ▲ **Primes Lead**
Development



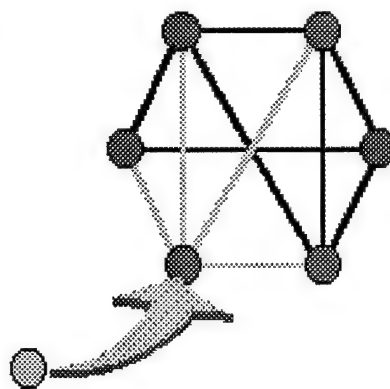
Integration of Integrations

- ▲ Increase functionality and effectiveness of System of Systems without adding systems
- ▲ Apply Data Resources to any system from any system



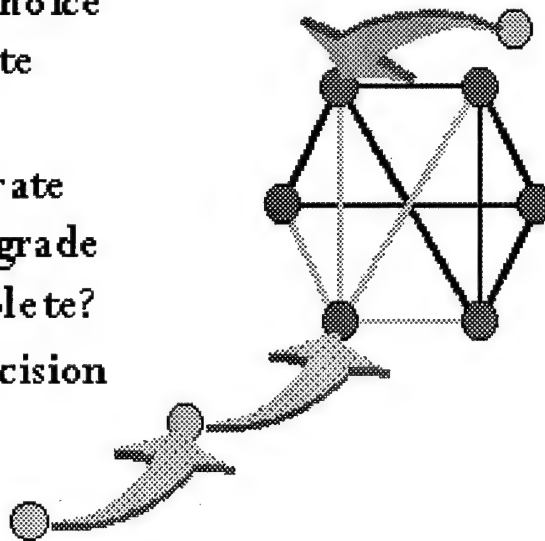
Continuous Integration of Integrations

- ▲ Commercial End Of Life
- ▲ New Open Standards
- ▲ New Systems
- ▲ New Integrations



Real-time Continuous Integration of Integrations

- ▲ We have no choice
but to integrate
upgrades
- ▲ Can we integrate
before the upgrade
becomes obsolete?
- ▲ DoD only Decision



Maintenance of Complex Software Systems

▲ What The Programs Will Soon Require

- Modification of complex software systems by personnel with little or no experience who must rely solely on new technology to succeed
- Modifications made relatively overnight and free as compared to full-scale development effort

▲ Do we have any silver bullets?

- No, but we are collecting some of the pieces

Development of Complex Software Systems

▲ Decrease Cycle Time

- Field prototypes

▲ Modify Development Process To Decrease Life Cycle Costs

- No affect to development costs

▲ Distributed Development

- Decrease Cycle Time and Increase Reliability

Sources For Solutions

- ▲ People
- ▲ Resources
- ▲ Money

People

- ▲ People to think of the solutions
- ▲ People to convey the solutions to the funding sources
- ▲ People to realize the solutions
- ▲ Teams from DoD, Industry and Academia work the best
- ▲ Software Technology is NOT institutionally funded at NAVAIR

Resources

- ▲ Advanced Software Technology Laboratory
- ▲ Develop Memorandums of Understandings and Cooperative Agreements to share resources with Academia and Industry

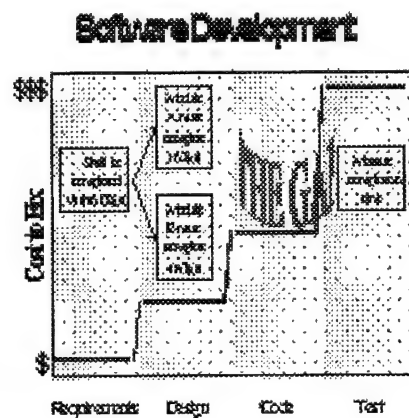
Money

- ▲ Direct Project Funding
- ▲ Small Business Innovation Research Program (SBIR)
- ▲ Corporate Investment Program
- ▲ Bid and Proposal B&P
- ▲ Office of Naval Research
- ▲ DARPA, NSF, Other Laboratories

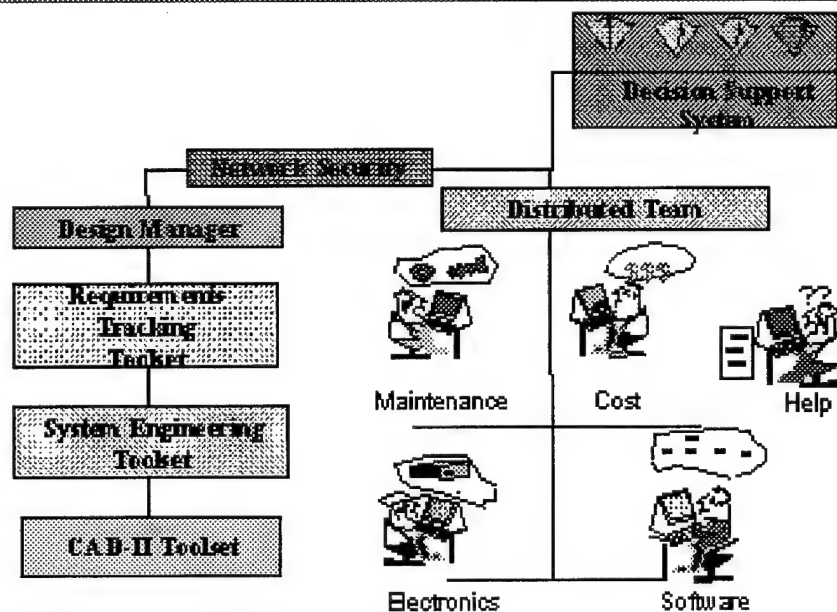
On Going Efforts

TEMPUS

- ▲ Software Metric to predict throughput in design and coding phase
- ▲ Fills the gap between throughput budgets allocated in the requirements phase and measured throughput in the integration phase

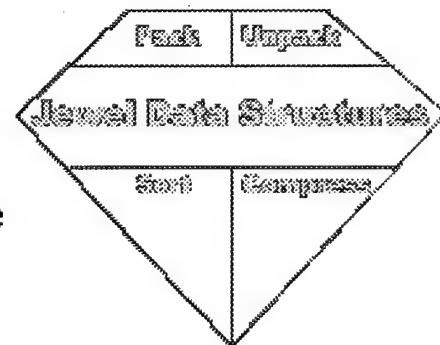


Collaborative Systems Engineering Workbench & Network



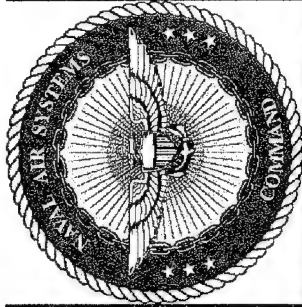
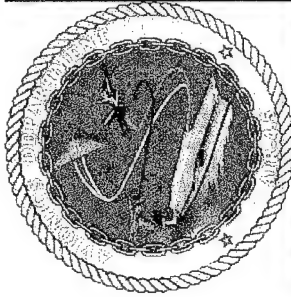
Jewel Compression

- ▲ Smart algorithm to capture, index and store continuous execution path data from real time software systems.
- ▲ Creates a database of how the system actually works while it is operating



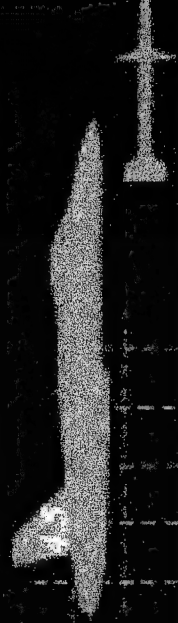
Summary

- ▲ **Money for small hard local problems is gone
and money for large general problems is hard
to get**
 - System of Systems - Network Centric
 - Maintenance and development of complex
software systems
- ▲ **We need to work together**
 - Share ideas, people, resources



NAVAL AIR SYSTEMS COMMAND

**RESEARCH &
ENGINEERING**



AVIONICS DEPARTMENT C4ISR&T AVIONICS

JAWS Conference
18 June 1998

CAPT Bud Jewett
Head, Avionics Department
(301) 342-0064

- Evolving Warfighting Environment
- Evolving Acquisition Environment
- Evolving Requirements for C4ISR&T

- Wide range of adversary types
 - Enemy more Mobile, Asymmetric, with Non-linear Operations
- Own forces -- Joint, Allied, Coalition
 - Rapid projection, Mobile, Flexible
- Sensor-to-Shooter response requirements
- Identification requirement -- "CNN" Factor

- Streamlining of processes
 - Contracting, Development, T&E, Deploy
- Commercial capabilities & technologies
- Modeling & Simulation usage
- Virtual platform (Lab) usage --
 - Development, T&E, Demos/Exercises

- Vertical & Horizontal Connectivity
- Bandwidth, Robustness, Timeliness, Interoperability
- Network Centric -- Sensor, Control and Engagement Grids
- Targeting Information -- Expedited, Seamless, BDA Feedback
- Blue (as well as Red) Situational Awareness

NAST C4ISR&T Working Group

- Coordination --
 - "East and West"
- Operational and Systems Architecture
 - Define for naval aviation
- Participation in Doctrine and Architecture defining events --
 - Demos, Exercises, Battle Experiments

C4ISR&T Coordination

- Systems Engineering approach --
 - Cross-Competency coordination
 - Cross-Systems Command and Programs
 - Teaming with Industry

Participation

- Labs -- Use as Virtual Platforms for:
 - Demonstrations --
 - Brassboard Capabilities
 - Insertion of new Technology
 - Nodes in Exercises / Battle Experiments
 - Doctrine and Architecture-defining events
 - Development of systems
 - Test & Evaluation -- own and cross-platform

Capabilities to Address

- Mission Planning & Rehearsal
- Command & Control of Air Assets --
 - Current Status,
 - Mission changes and results
- Sensor-to-Shooter capabilities --
 - Threat, Targeting, and BDA info

- Interoperability-driven requirements --
 - Navy air, surface and sub-surface connectivity
 - Joint, Allied, and Coalition connectivity
- Joint Technical Architecture (JTA)
- Defense Information Infrastructure (DII)
Common Operating Environment (COE)
- Global Command & Control System (GCCS)
 - special connectivity requirements

Overall Objectives

- Naval Aviation as full partner --
 - C4ISR&T Doctrine and Architecture
- Network Centric connectivity
 - Response to varied / changing battle situations
- Streamlined Acquisition capability
- Infrastructure that is interoperable for:
 - Development, T&E, Participation as Nodes in Demos and Exercises

4.5

Avionics

Questions???

1128

The Application of Statistical Methods to Software Test

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Why do we test software?

Example objectives:

- Demonstrate that, at this point in the life cycle, the process is in control.
- Demonstrate that the software is ready for fielding.

How do we measure the success or failure of the software test?

We apply scientific investigation methods:

- Formulate hypotheses based on objectives
- Design experiments to test the hypotheses
- Perform experiments
- Evaluate results
- Develop conclusions based on results

Formulate hypotheses

Example objective:

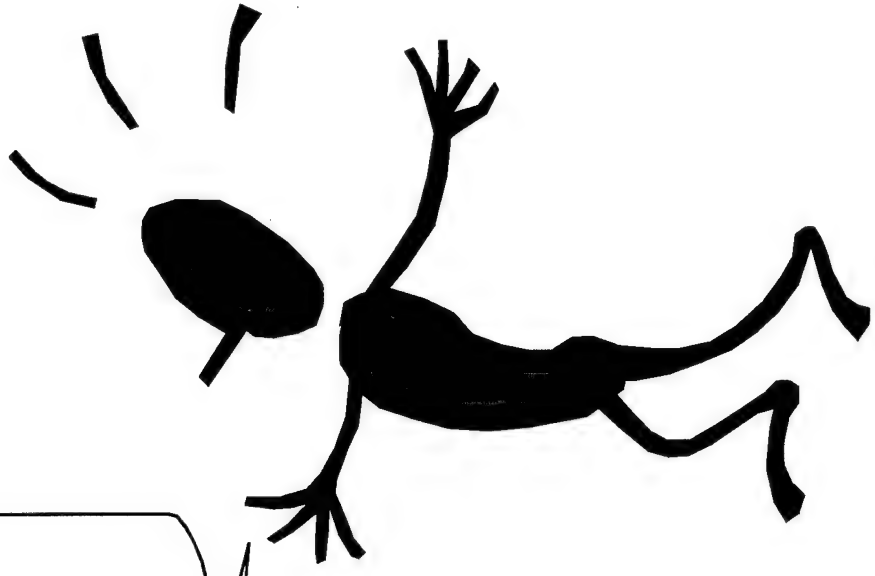
“Demonstrate that the process is in control”

Example hypothesis:

“The software will experience no more than
___ failures of type ___ when tested under
___ conditions.”

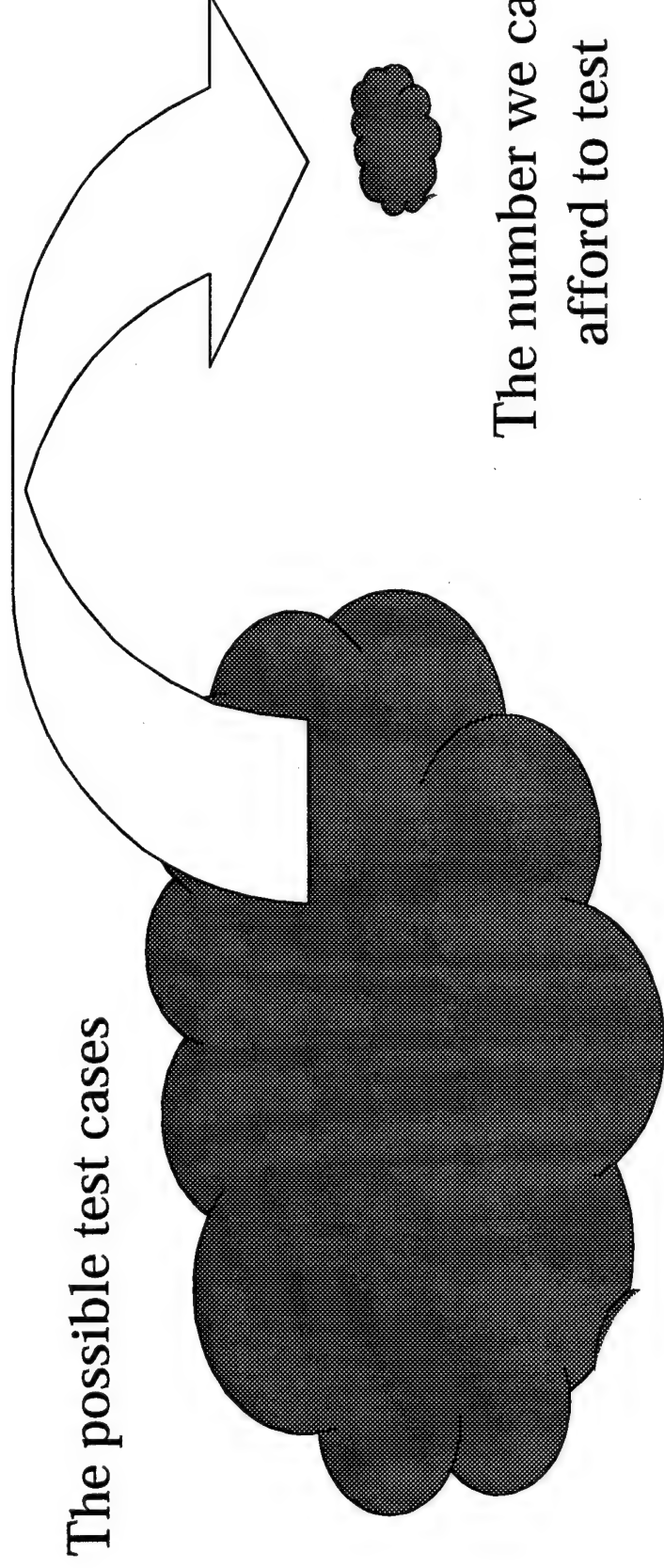
Design an experiment: How???

We can't test every possible
combination of input, state, and
environment!!



Software Testing is Sampling

(How do we select the sample?)



(What is the risk of not testing all?)

There are many test case selection techniques

- ï Political considerations
- ï Existing regression test suites
- ï Boundary value analysis
- ï Code coverage
- ï Functional coverage
- ï Use case analysis
- ï ...

The Hard Fact

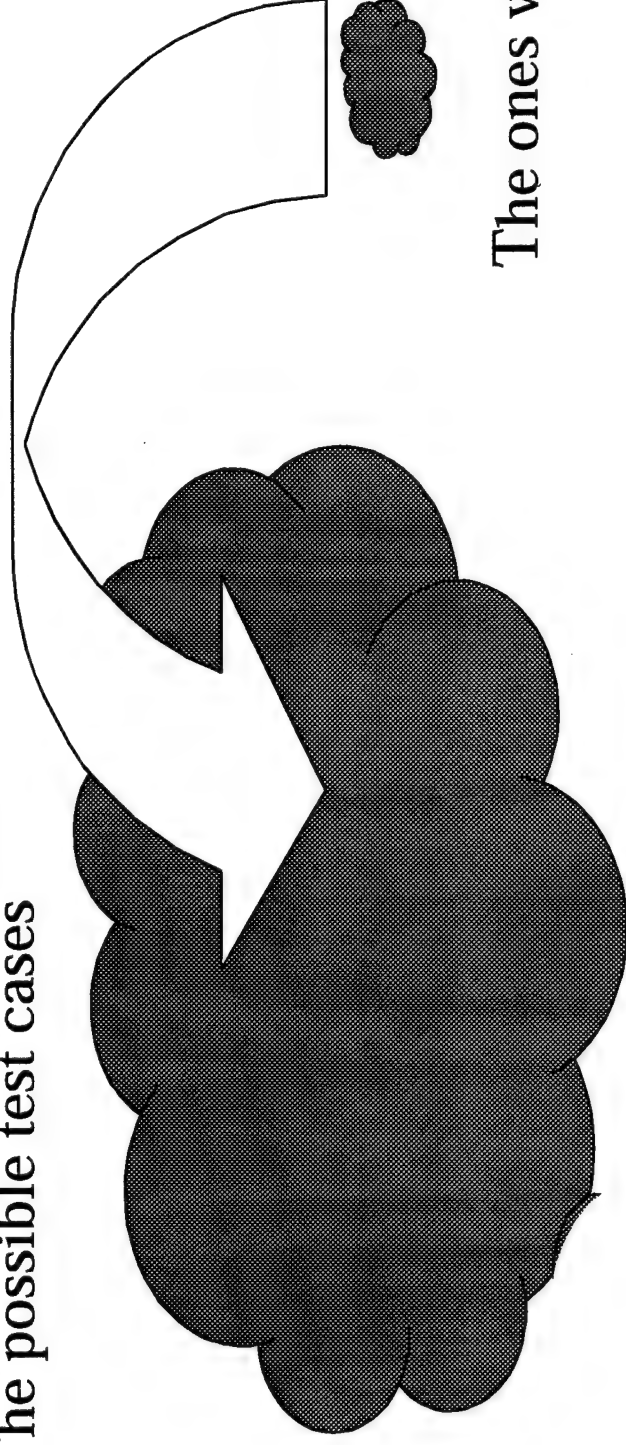
After we finish testing, there are two distinct sets:

- i Our sample: the test cases we executed and evaluated -- we know something about these.
- i The rest of the population: the test cases we didn't execute -- the user will be the first to execute these.

Conclusions based on test results

(How do we describe the sample in terms of the whole?)

The possible test cases



The ones we tested

(How do we describe the ones we did not test?)

Statistical methods for test and evaluation of software

- ï Scientific investigation methods to guide the test activities.
- ï Experimental design methods to characterize and represent the population of possible software use.
- ï Mathematical modeling, simulation, and analysis to support test planning, execution, and evaluation.

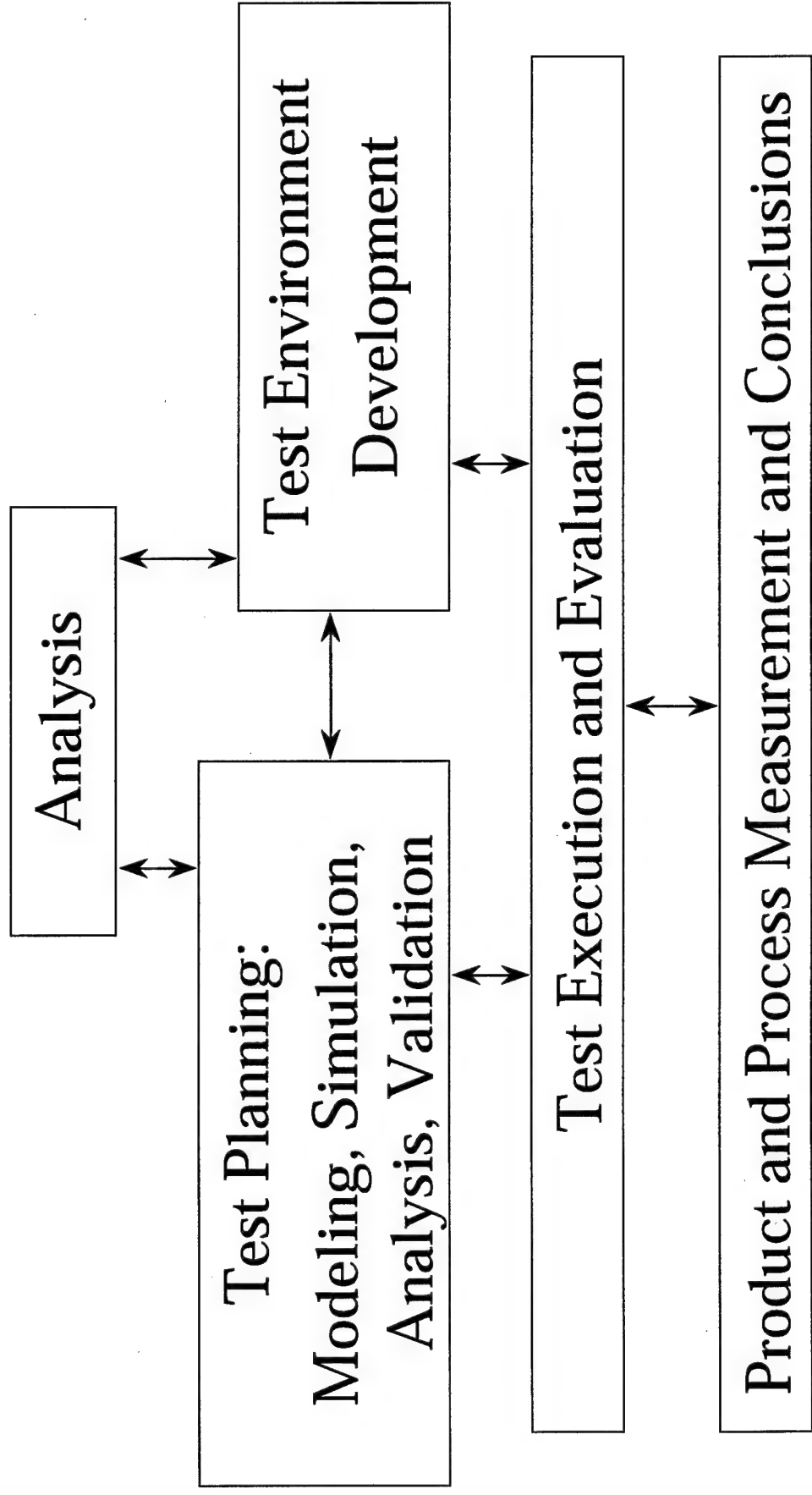
Statistical methods (cont.)

- i Operations research techniques for specifying objectives and constraints, performing analyses, and making optimal choices.
- ii Statistical methods for partitioning the population of possible software use, selecting statistically valid samples, and making inferences to the entire population based on results from testing the sample.

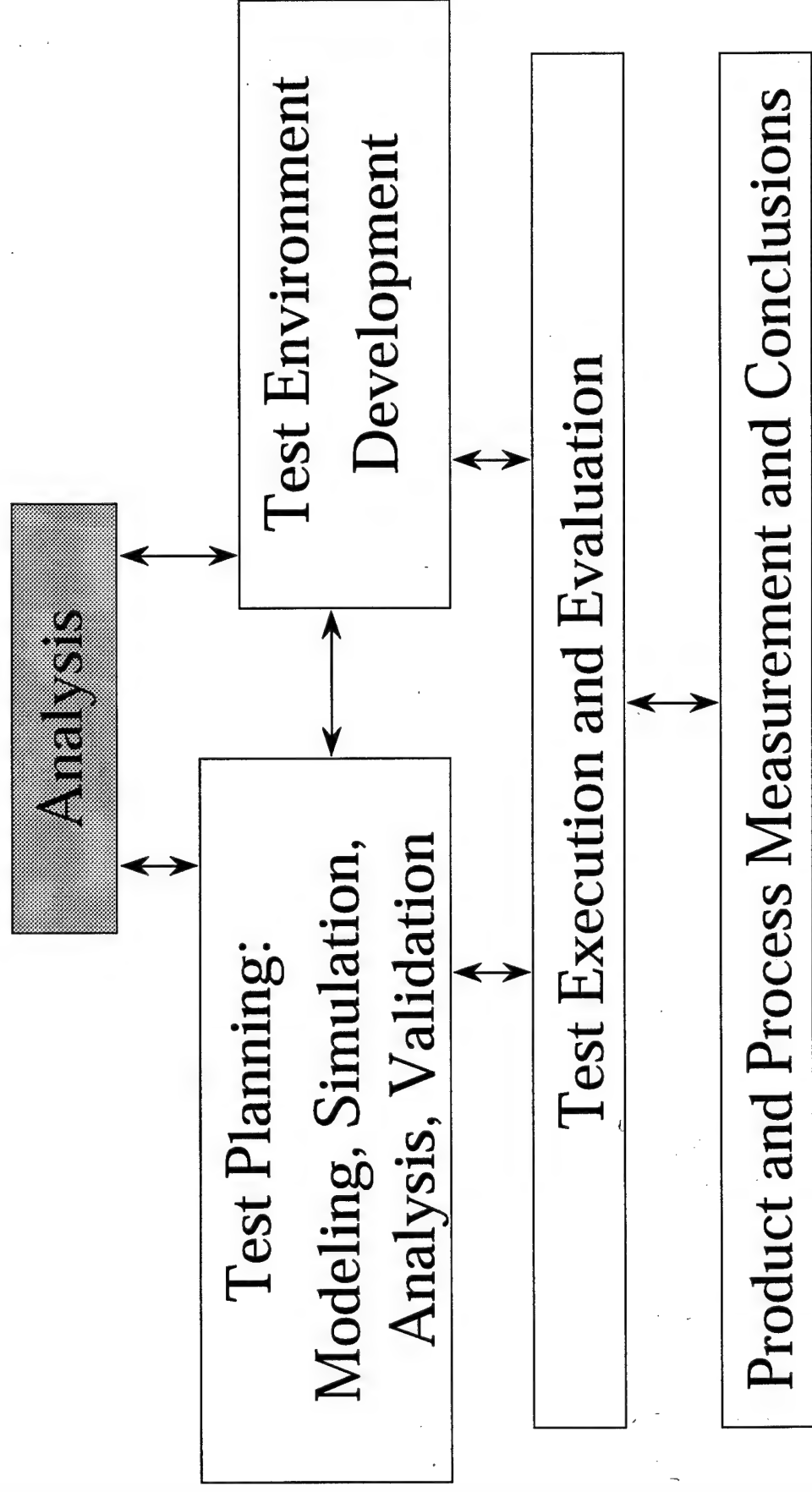
Benefits of statistical methods

- ii Quantitative analysis of software specifications before code is completed.
- ii Quantitative test planning and evaluation support.
- ii Automatic generation of statistically correct sample of test cases.
- ii Test and evaluation simulation.
- ii Support for automated test execution and evaluation.
- ii Quantitative analysis of test results.

The Statistical Testing Process

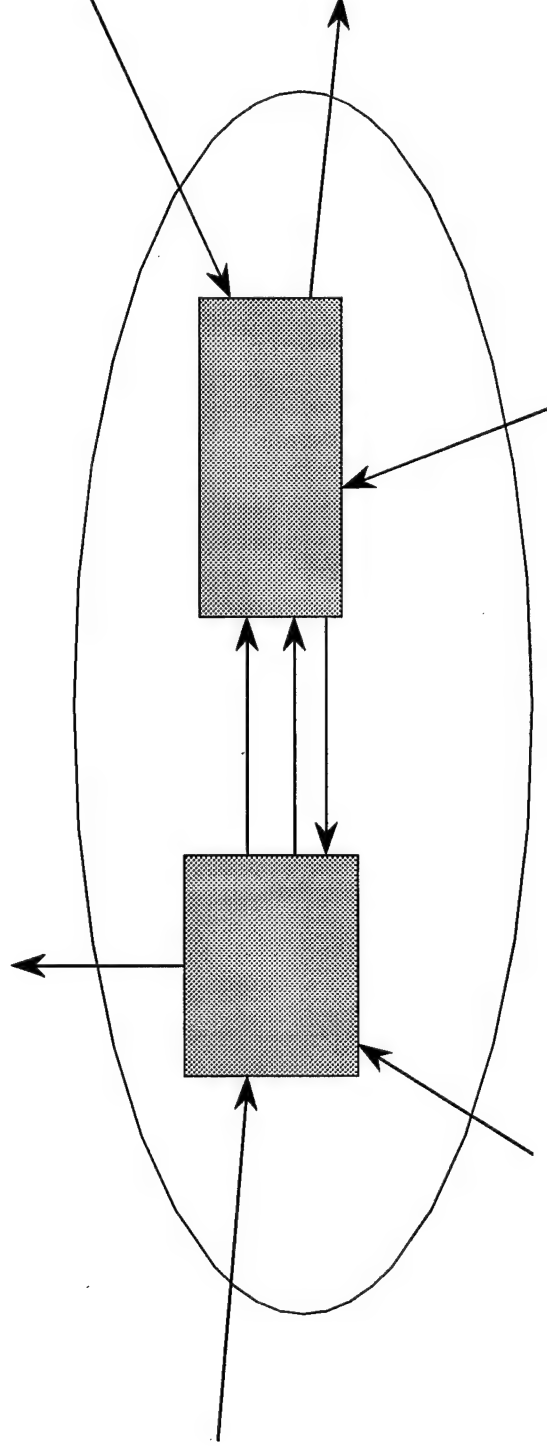


The Statistical Testing Process



Determine test boundary

- ï What part(s) of the software do we test?
- ï In what environment?



Determine specific test objectives and constraints

Sources of objectives and constraints:

- Expected or hypothesized usage
- Management issues (cost, schedule, priorities, Ö)
- Technical issues (features, requirements traceability, test environment, dependencies with other test and development schedules, Ö)

Consider life cycle phases

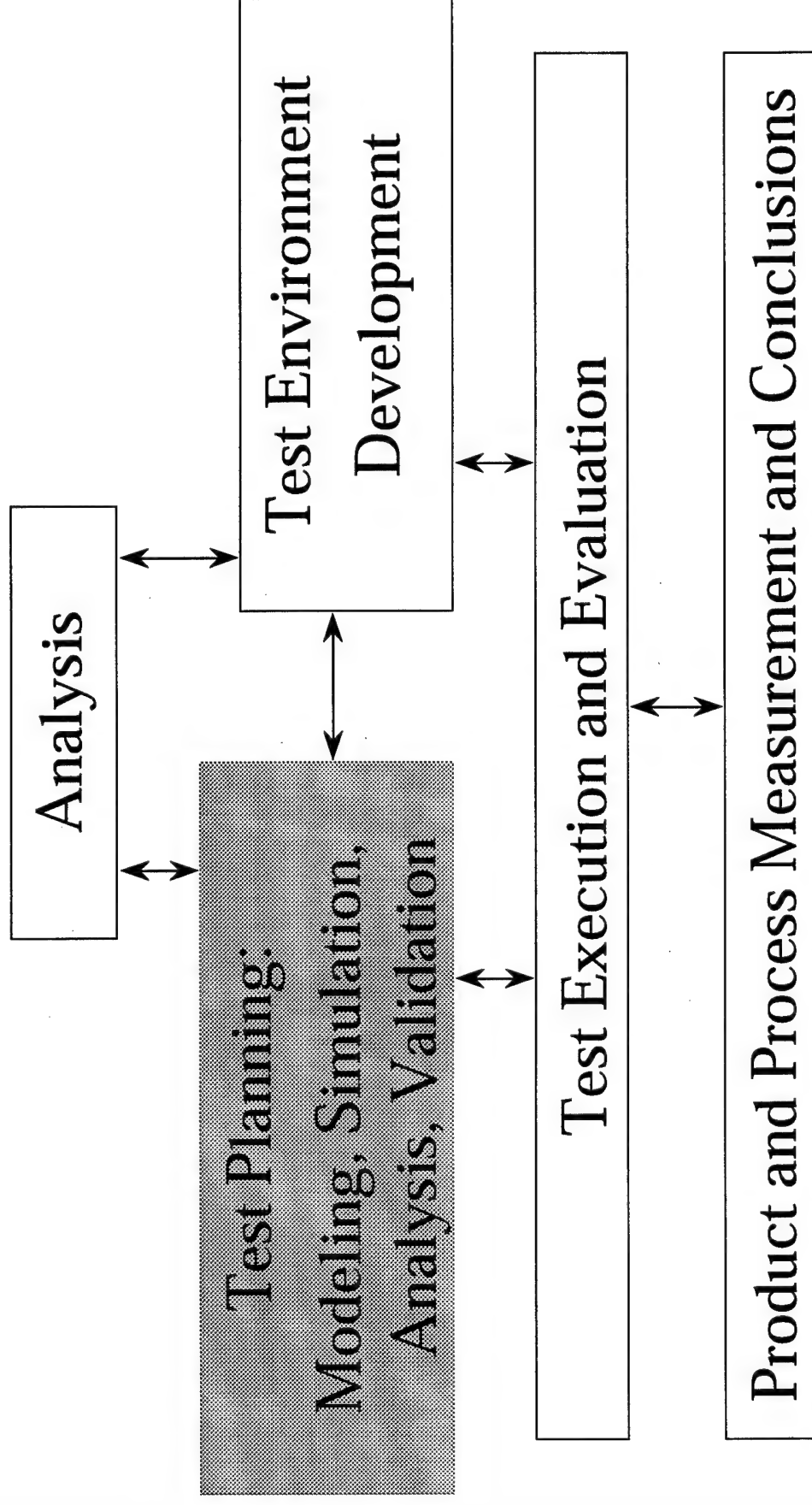
At different points in the life cycle, the test objectives will differ. For example:

- ï Cover all usage states as quickly as possible to get an early indication of quality.î
- ï Mimic as closely as possible a particular category of expected usage. Test enough to give a statistically valid estimate of reliability for this usage category.î

Evaluate test strategies

- ii Simulation or operational test
- ii Degree of automation
- ii Oracle
- ii Stopping criteria
- ii Ö

The Statistical Testing Process



Usage modeling: characterize the population of possible use

- i Precisely define high level usage stratification
 - ñ users
 - ñ uses
- i Determine how many models to develop

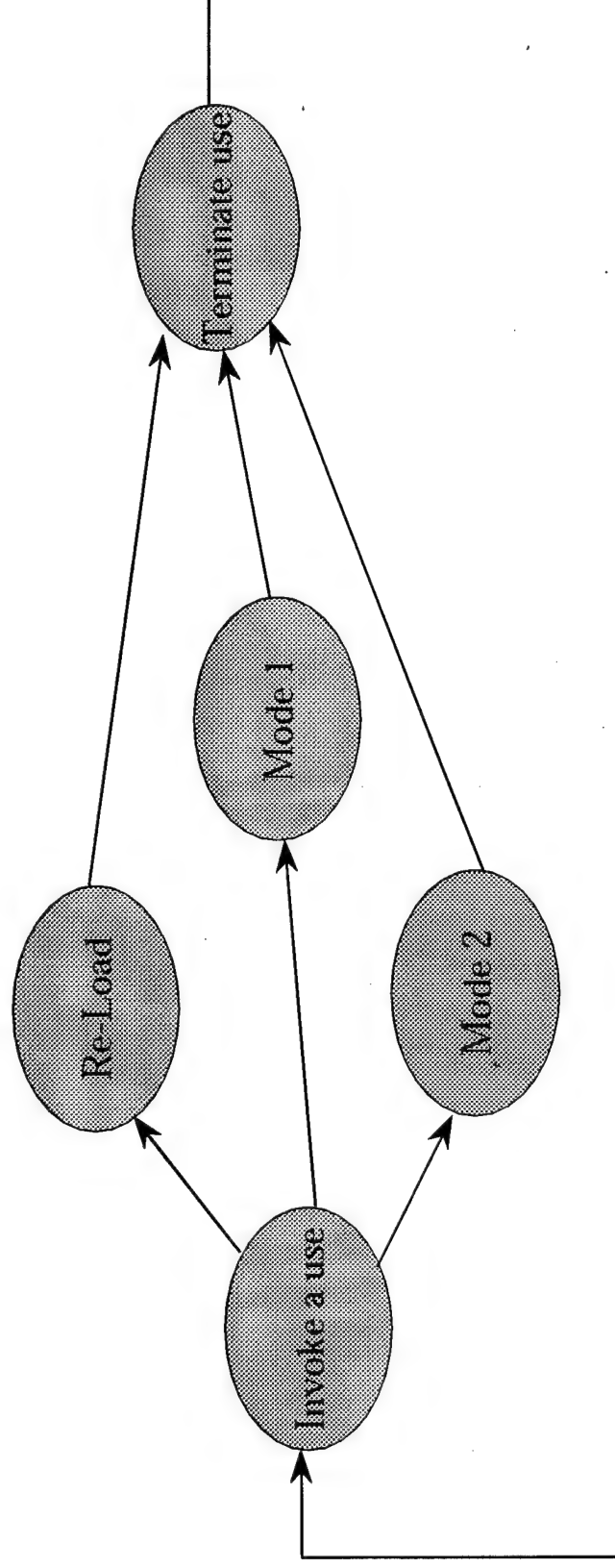
Usage modeling: represent the population of possible use

- ï Build a formal representation of all possible uses of the system for each user/use.
- ï Select a modeling strategy that will support statistical analyses for model validation, test planning, and test evaluation.

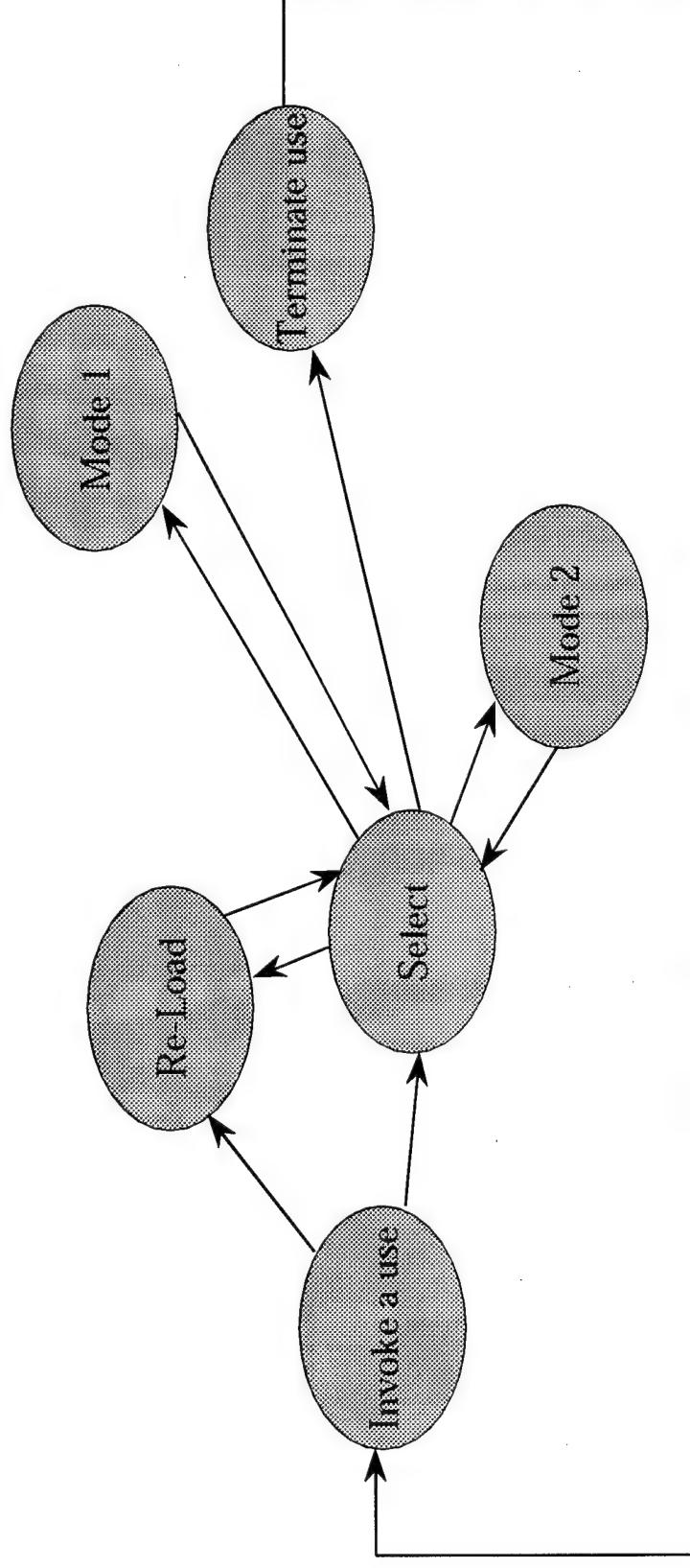
Markov chain usage models

- i The structure of a usage model for a system is a hierarchy of component usage models.
- i Each component model's structure can be represented by a state transition graph: nodes represent states of use and arcs represent possible transitions between states.

High-level usage model structure: use stratified by mode of operation

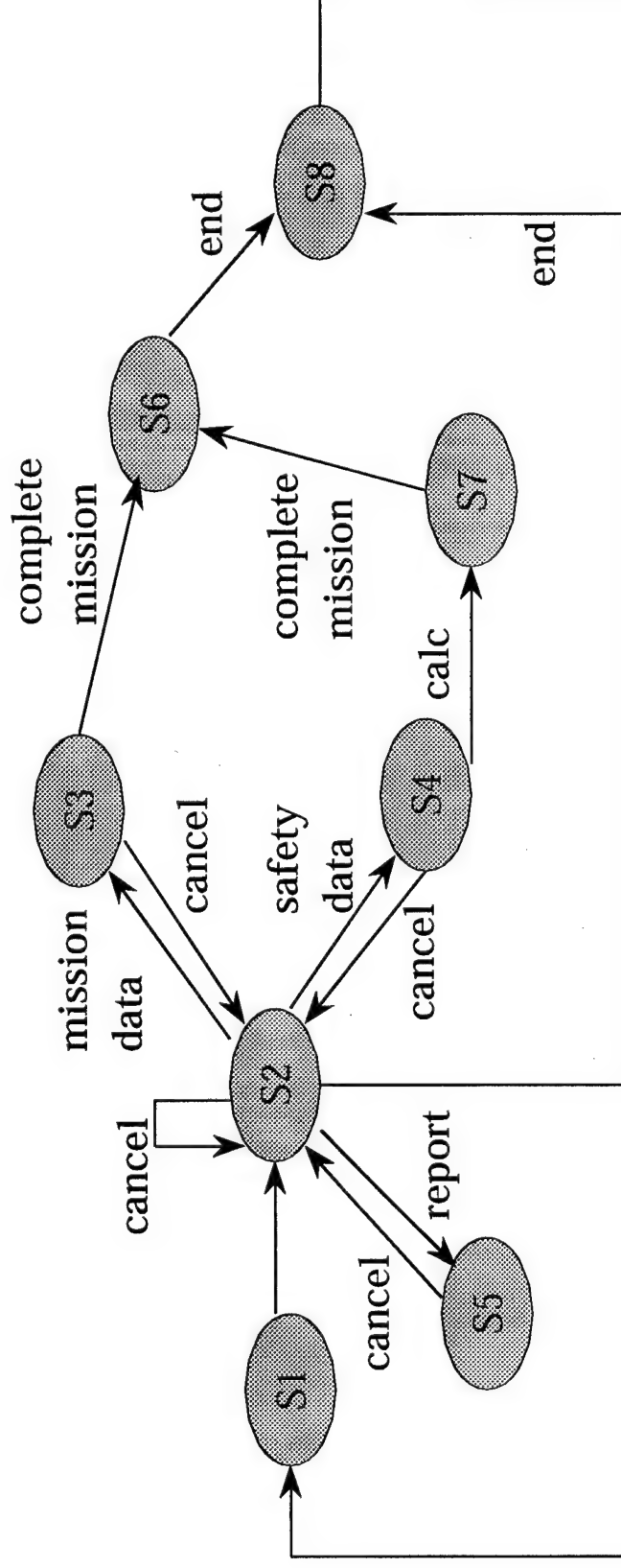


High-level usage model structure: based on functional specification



Second-level usage model

structure: Mode 1



Usage model structure validation

- Does the model represent all possible uses?
- How do the paths, test evaluation criteria, and test environment map to software requirements?
- Do we need multiple arcs between two particular states to represent selection of different data or performing different procedures?
- What determines successful execution at each state?

UM structure validation (cont.)

- ï What data are required at each arc?
- ï What procedures are required to set up the data, execute the test, and capture and evaluate the results?
- ï Can we execute and evaluate each path?
- ï Can we automate test execution and evaluation?
- ï ...

State transition probabilities

- i We model software use as a stochastic process with decisions to be made at each state.
- ii Each arc is assigned a transition probability.
- ii The model yields a transition probability matrix.
(finite state, discrete parameter, time homogeneous, recurrent Markov chain)
- ii We can draw on the rich body of Markov chain mathematics to analyze the model.

Specify probabilities as mathematical functions: use constraints and objectives

- i iat state 2 a user enters mission data 30% of the timeî would be represented as: $p_{s2,s3} = 0.3$
- ii Typically there is insufficient information to specify a value. îlt is at least 3 time more important that we test the transition from s2 to s4 than the transition from s2 to s5î would be represented as: $p_{s2,s5} < 3^*p_{s2,s4}$

UM maintenance and reuse

- i Update the functions as new information is available about expected use, test constraints, test objectives.
- i Use standard mathematical programming techniques to determine an optimal set of transition probabilities to use for testing.
- i Reuse a usage model structure with different transition probabilities at different points in the life cycle.

Usage model analysis

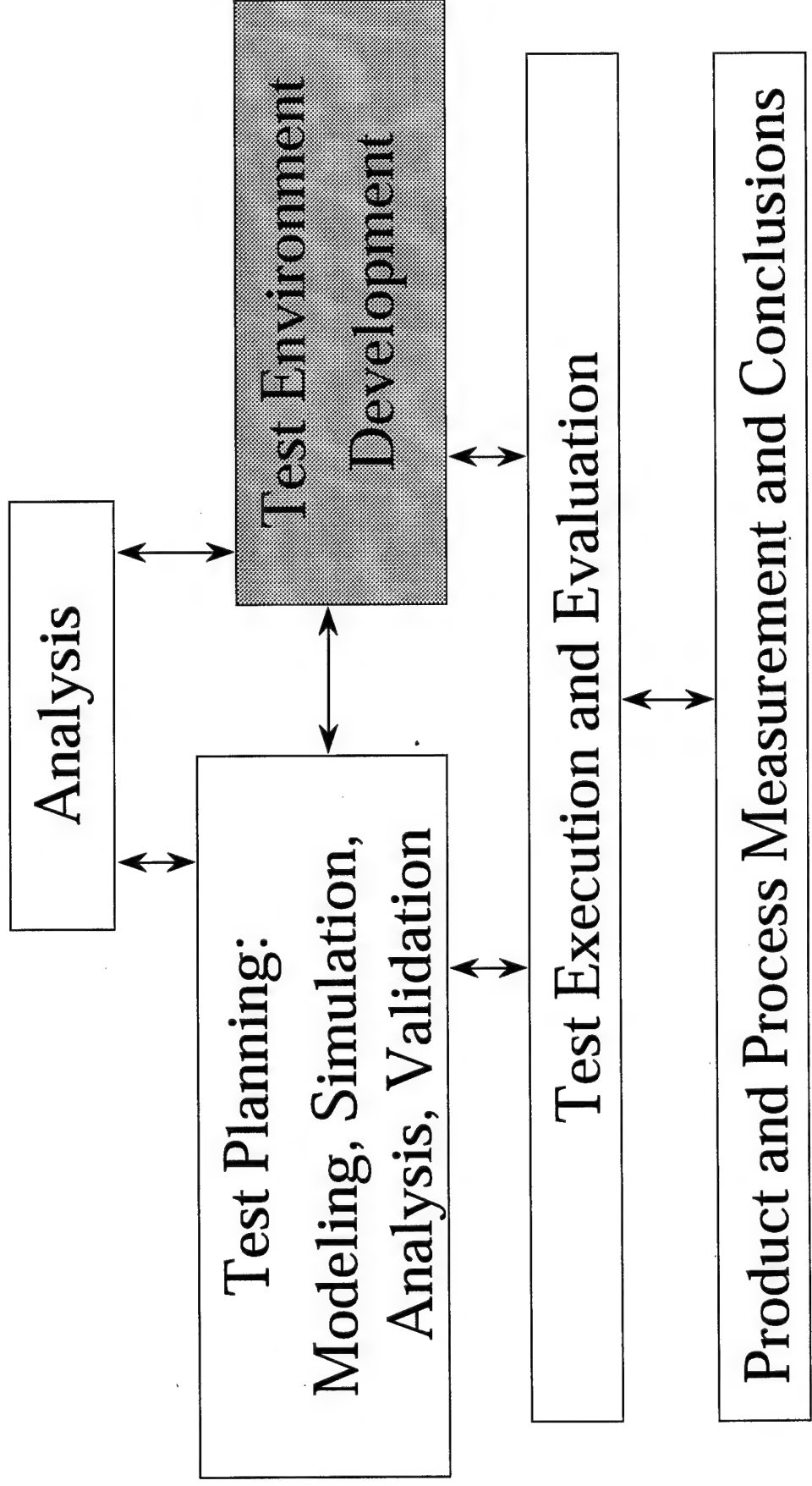
From the model, calculate statistics such as

- length of average test sequence
- estimated proportion of test budget that will be spent testing a particular part of the model
- amount of testing required before reaching a particular state or arc
- probability of a particular state occurring in a test sequence
- number of statistically typical paths in the model

Test simulation

- ï Automatically generate test sequences from the model.
- ï Make hypotheses about test results.
- ï Generate a Markov chain to represent the test experience.
- ï Analyze the simulated testing chain.
 - ñ model validation
 - ñ test planning support

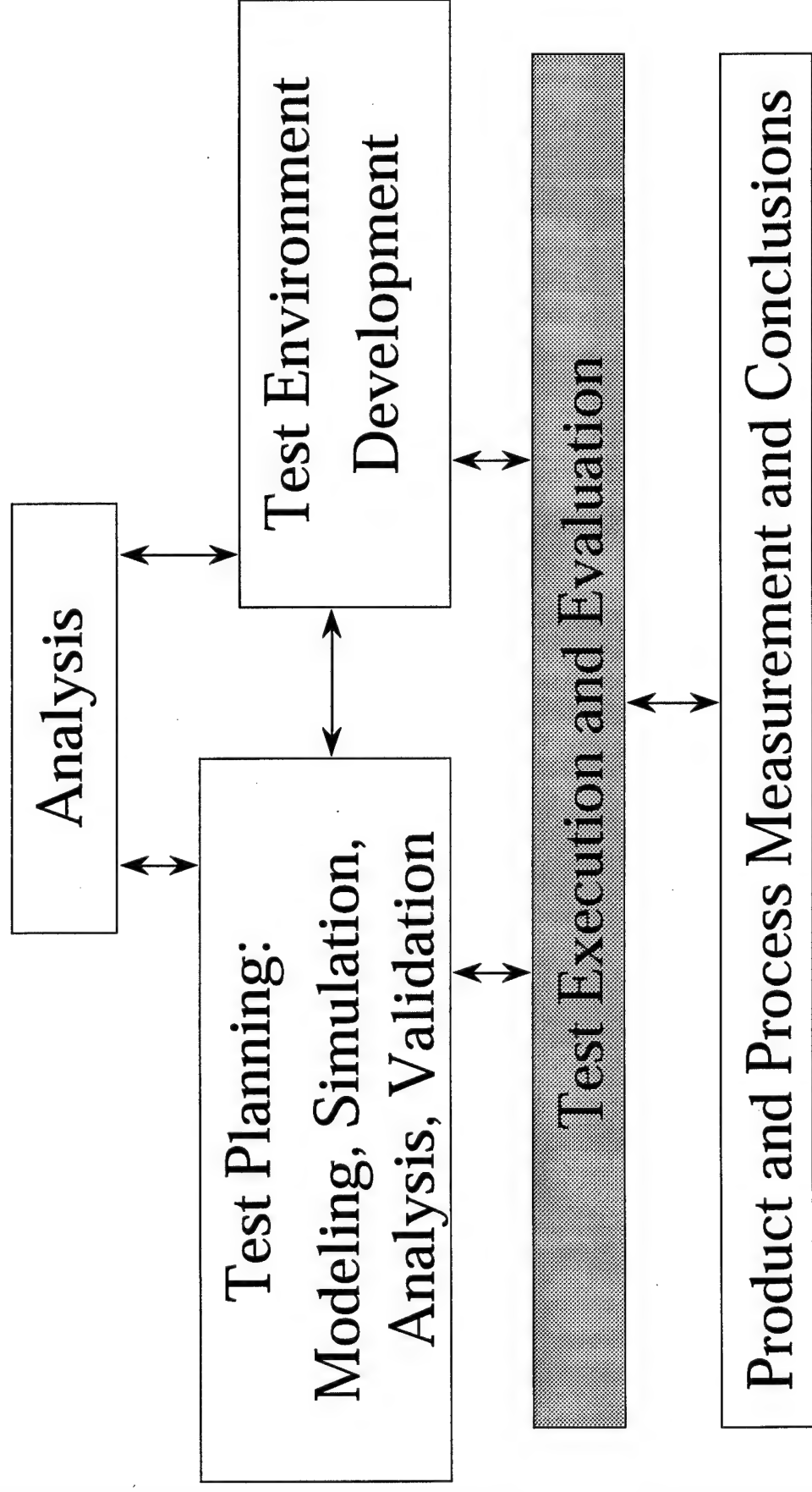
The Statistical Testing Process



Test environment development

- ï Parallel effort to application development
- ï Often is a significant effort

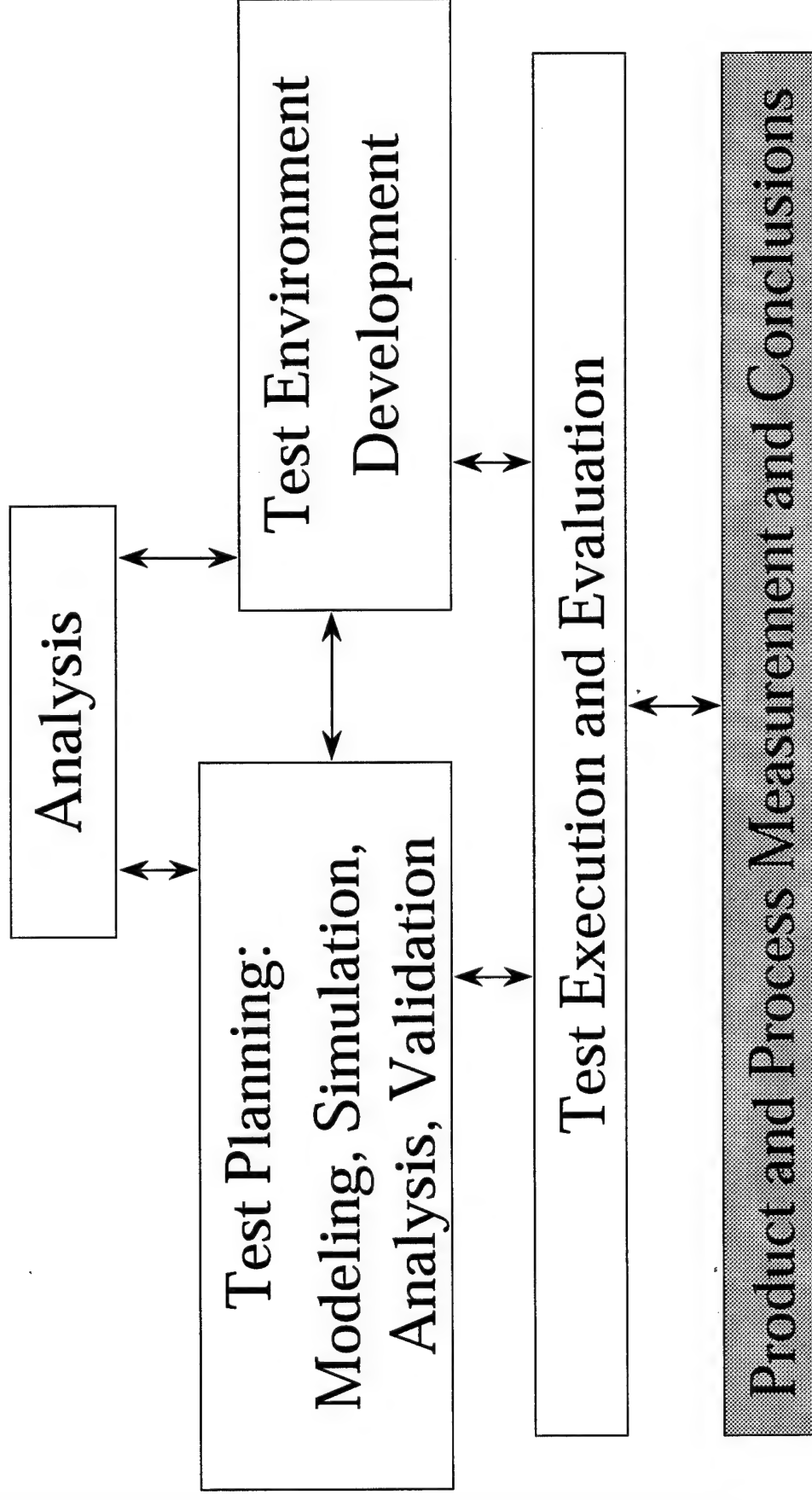
The Statistical Testing Process



Sequence of events

- ii Develop usage model and oracle.
- ii Automatically generate test sequences.
- ii Transform sequences as required to support automation.
- ii Execute scripts on the system under test (use an automated test runner if available).
- ii Evaluate test results using the oracle.

The Statistical Testing Process



Measurement

- ï Build a Markov chain from test results.
- ï Compare testing chain to usage model and calculate measures of
 - ñ reliability
 - ñ test sufficiency.
- ï Recognize that these are calculated statistics based on the testing. (And that is all that they are!)

Determine conclusions

- ï Evaluate the entire testing process
 - ñ How well did we characterize and represent the population of use?
 - ñ How many test sequences did we execute and evaluate?
 - ñ What types of usage do these sequences represent?
 - ñ What data, procedures, and environment did we use?
 - ñ What possible paths through the model did we NOT execute and/or evaluate?
 - ñ What possible data (input, state, and environment) combinations did we NOT use?
- ï What conclusions can we make?



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TESTER
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JAWS Symposium & Exhibition

June 18, 1998

SOLUTIONS FOR EMBEDDED SYSTEM DEVELOPMENT

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SOLUTIONS FOR EMBEDDED SYSTEMS INTEGRATION

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APPLICATION SUMMARY

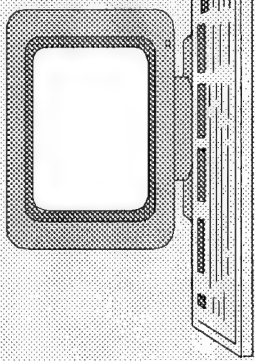
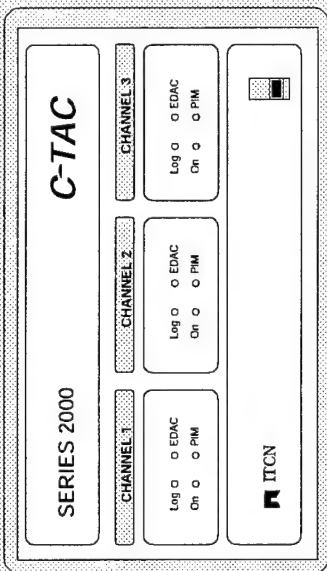
PLATFORMS

- AV-8B • F-15
- A-10 • F-15I
- B-2 • F-18
- C-17 • CF-18
- C-130 • RAAF-18
- AC-130U • F-111
- EA-6B • GR-7
- F-14 • P-3
- A-4

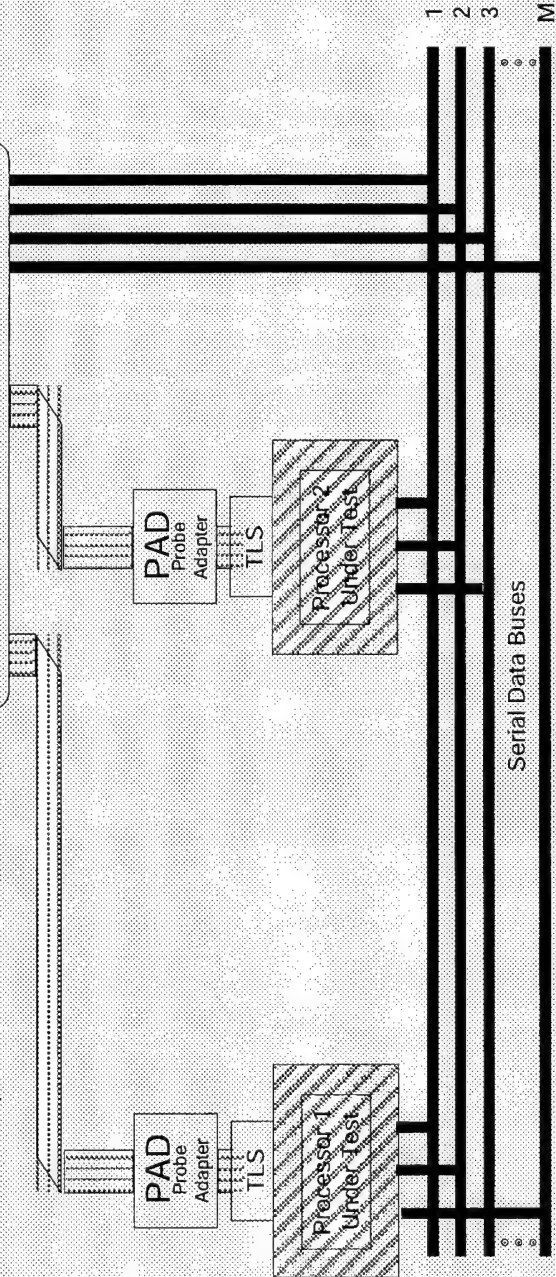
PROGRAMS

- ACM
- ALQ-135
- AN/ALQ-172
- ATARS
- AYK-14
- CASSINI
- CDNU
- IDAL
- SCNS
- SOF-EISE
- ALQ-155

Multi-Channel C-TAC Base Unit



Operator interface terminal



Typical multiple target application of C-TAC with N processors and M data buses

C-TAC EMBEDDED SYSTEM ANALYZER



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CONTROLLER

What is C-TAC?

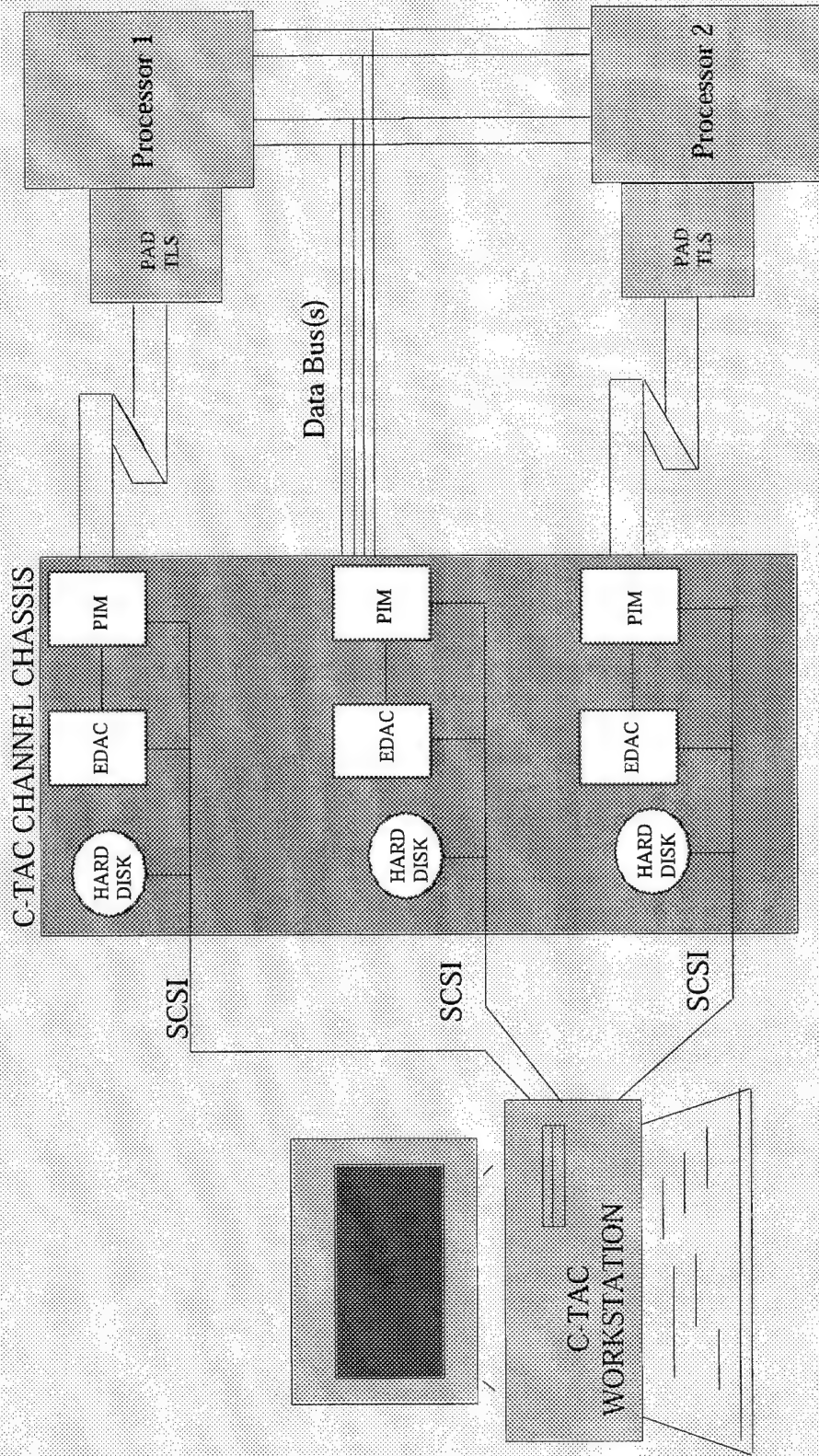
- 6 Embedded Computer System Development Tool
- 6 Combination of Data Acquisition, Logic Analyzer, Bus Analyzer, and In-Circuit Emulator in a User Friendly, Integrated Package
- 6 Stand-Alone Instrument Controlled by a Personal Computer (Included)
- 6 Tailored to Users Processor/Bus Application



SOLUTIONS FOR EMBEDDED SYSTEMS INTEGRATION

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C-TAC Components



TYPICAL C-TAC SYSTEM FOR 1750

C-TAC BASE UNIT WITH 3 CHANNELS INSTALLED

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CONTROLLER

What Does C-TAC Do?

- 6 Traces Data Flow Throughout the System
- 6 Monitors Multiple Targets in Real-Time without Impacting System Timing or Event Sequencing
- 6 Collects Data "Smartly" based on Hardware Filtering
- 6 Interfaces to Compiler Tools for "Point and Click" Symbolic Specification of Data to be Monitored
- 6 Displays Engineering Units in addition to Raw Data (Binary, Octal, Hex)
- 6 Includes Classical Debugger Features for Processor Channels
- 6 Supports Ada Level Software Debuggers

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How is C-TAC Used?

6 Processors

- Data Tracing
 - » Monitor Variables for Anomalies and Determine Instruction/Routine Causing Anomalous Behavior
 - » Monitor for Critical Combinations of Events or Data Values
- Timing
 - » Transport Delays within Processor Software
 - » Execution Time Profiles of Software
 - » "Spare" Execution Time Available
- Instruction Tracing
 - » Full Trace Capability by Routine
 - » Jump Traces
 - » Calling Tree Determination
 - » Program Flow

How is C-TAC Used (Continued)?

6 Buses

- Data Tracing
 - » Monitor Variables for Anomalies and Determine which Terminal Generated Anomalous Data
 - » Monitor for Critical Combinations of Events or Data Values

6 Timing

- Data Bus Transport Delays
- Bus Message Sequence Verification
- Bus Timing Profiles

6 Statistics

- Bus Loading
- Message Errors
- Bit Errors

How is C-TAC Used (Continued)?

6 System

- Data Tracing
 - » System-Wide Capability through cross-channel triggers
 - » Cross-Channel Event Combinations used to Qualify Data Collection
 - » System Data Flow Tracing
- Timing
 - » System Transport Delays
 - » System Loading
 - » Critical Timing/Loading Determination
 - » Critical Process Sequencing across Subsystem Boundaries



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CONTROLLER

What are the Benefits?

6 Enhanced Productivity

- Symbolic Test Specification and Data Display
- Sophisticated Filtering Collects only Data of Interest under Conditions of Interest
- Linked Analysis Tools Support Instant Location of Anomalous Raw Data
- Graphical Presentation of Procedure/Bus Message Timing
- On-Line Statistics for 1553 Buses

6 Reduced System Integration Time

- Multi-Channel C-TAC Monitors Multiple Points in System
- Critical System Timing Easily determined
- End-to-End Verification of Data Flow and Timing
- Critical System Procedure Flow Verification



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What are the Benefits (Continued)?

6 Improved System Quality

- More Thorough Evaluation
- Improved Understanding of Intra-System Relationships
- Improved Ability to Verify Data and Processes

6 Reduced Costs

- Fewer Personnel due to Enhanced Productivity
- Reduced Time to Develop and Integrate
- Fewer Latent Problems

1

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1553 LOG

File Setup Filter Search Place Mark Find Event Find String

Rec #	Time	TA	I/R	SA	WC	Word	Type	Xfer	Value	Event	Symbolic Name
7829	0:00:09.098 932 000	4	R	3	2	Qnd	Qnd	M-R	4 R 3 2 Qnd		A:RI_4
7830	0:00:09.098 932 000	4	R	3	2	D01	Data	M-R	1498.051		A:FCC'ALTITUDE
7832	*** PROTOCOL ERROR ***						No Response		TA= 4, I/R=R, SA= 3, WC= 2		

Chronological Review
 7835 0:00:09.098 183 000 1 1
 7836 of Collected Data

7838	0:00:09.138 247 000	2	I	3	6	Qnd	Qnd	R-M	1 I 1 2 Qnd		A:RI_1
7839	0:00:09.138 269 000	2	I	3	6	Sts	Status	R-M	01 000		A:RI_1
7840	0:00:09.138 289 000	2	I	3	6	D01	Data	R-M	1497.63		A:FCC'ALTITUDE
7842	0:00:09.138 329 000	2	I	3	6	D03	Data	R-M			
7844	0:00:09.138 369 000	2	I	3	6	D05	Data	R-M			

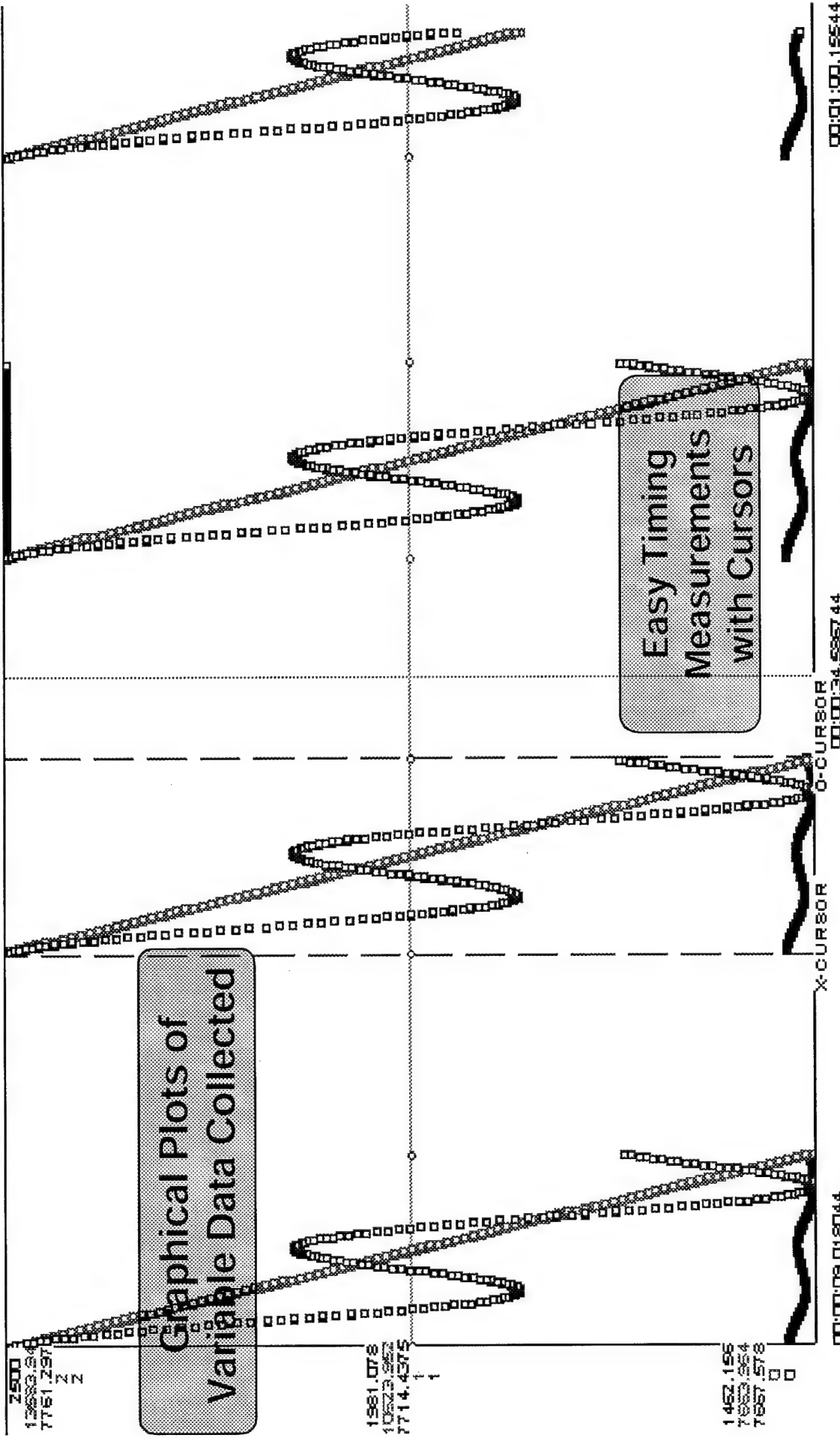
1750 LOG

File Setup Filter Search Place Mark Find Event Find String Collect & Review Data from

Rec #	Time	Address	Status	Value	Event	Symbolic Name
258	0:00:09.098 618 000	0x000000829	STL			A:FCC'BNB'RELEASE
260	0:00:09.098 619 000	0x00000055c	OPRND WRITE	13567.91		A:FCC'RANGE'TO'TARGET
262	0:00:09.099 153 000	0x000000822	STL			A:FCC'BNB'RELEASE
264	0:00:09.099 154 000	0x000000560	OPRND WRITE	7760.897		A:FCC'RANGE'OF'FALL
267	0:00:09.118 136 000	0x0000006f2	STL			A:FCC'BNB'RELEASE
269	0:00:09.118 136 000	0x000000550	OPRND WRITE	1497.856		A:FCC'ALTITUDE
271	0:00:09.118 209 000	0x000000785	STL			A:FCC'BNB'RELEASE
272	0:00:09.118 210 000	0x000000552	OPRND WRITE	13504		A:FCC'LATITUDE
274	0:00:09.118 239 000	0x000000738	STL			A:FCC'BNB'RELEASE
276	0:00:09.118 240 000	0x000000554	OPRND WRITE	2.002144		A:FCC'LONGITUDE
278	0:00:09.118 597 000	0x000000829	STL			A:FCC'BNB'RELEASE
280	0:00:09.118 597 000	0x00000055c	OPRND WRITE	13503.93		A:FCC'RANGE'TO'TARGET

STEP

File Events Graph Zoom In Zoom Out Refresh

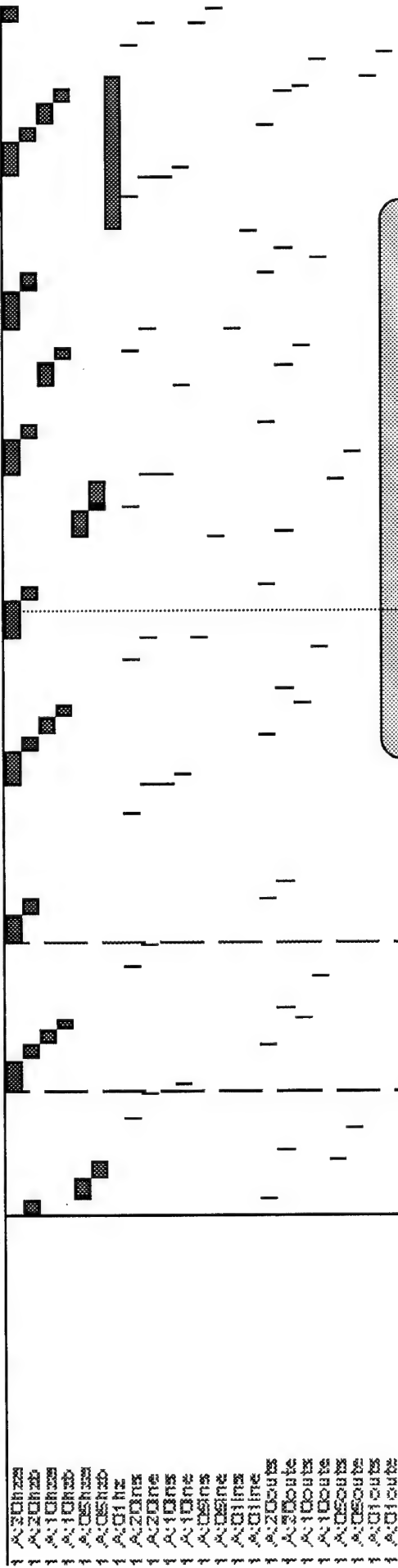


EVENT

EVENT	X-CURSOR	O-CURSOR	O-CURSOR	TIME DIFFERENCES
01 AFCC ALTITUDE	1470.57	1470.86	1470.86	C - X Time: 00:00:10.653625
01 AFCC RANGE TO TAR	7679.96	7683.96	7683.96	O - C Time: 00:00:03.069244
01 AFCC RANGE OF FAL	7689.68	7690.4	7690.4	O - X Time: 00:00:07.535381
01 AC PILOT CONSENT	1	1	1	
01 AC RELEASED	1	1	1	

CTAC time: 00:00:23.933119 00:00:34.586744 00:00:31.518500

File Events Graph Zoom In Zoom Out Refresh



Graphical Profiling of
Code Execution or
Message Traffic

Easy Timing
Measurements
with Cursors

X-CURSOR 0-CURSOR
00:00:21.969217 00:00:22.066625

X TIME: 00:00:21.969217
O TIME: 00:00:22.066625
O TIME: 00:00:21.969217

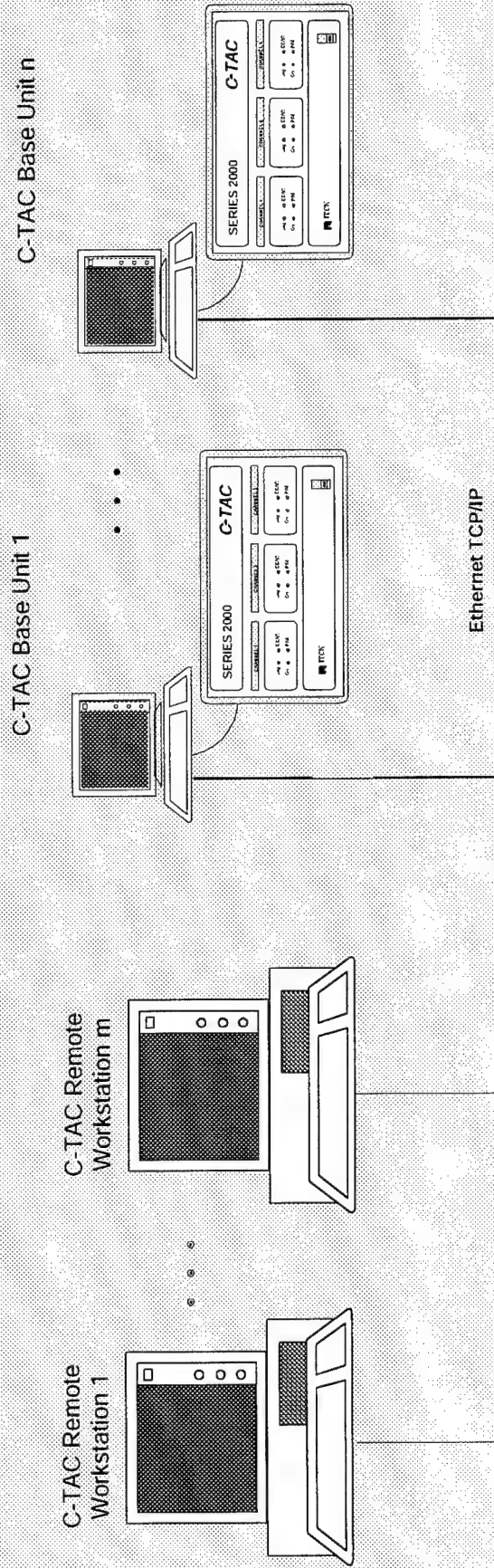
O-X TIME: 00:00:00.196812
O-C TIME: 00:00:00.106256
O-X TIME: 00:00:00.048556

00:00:22.25403

1184

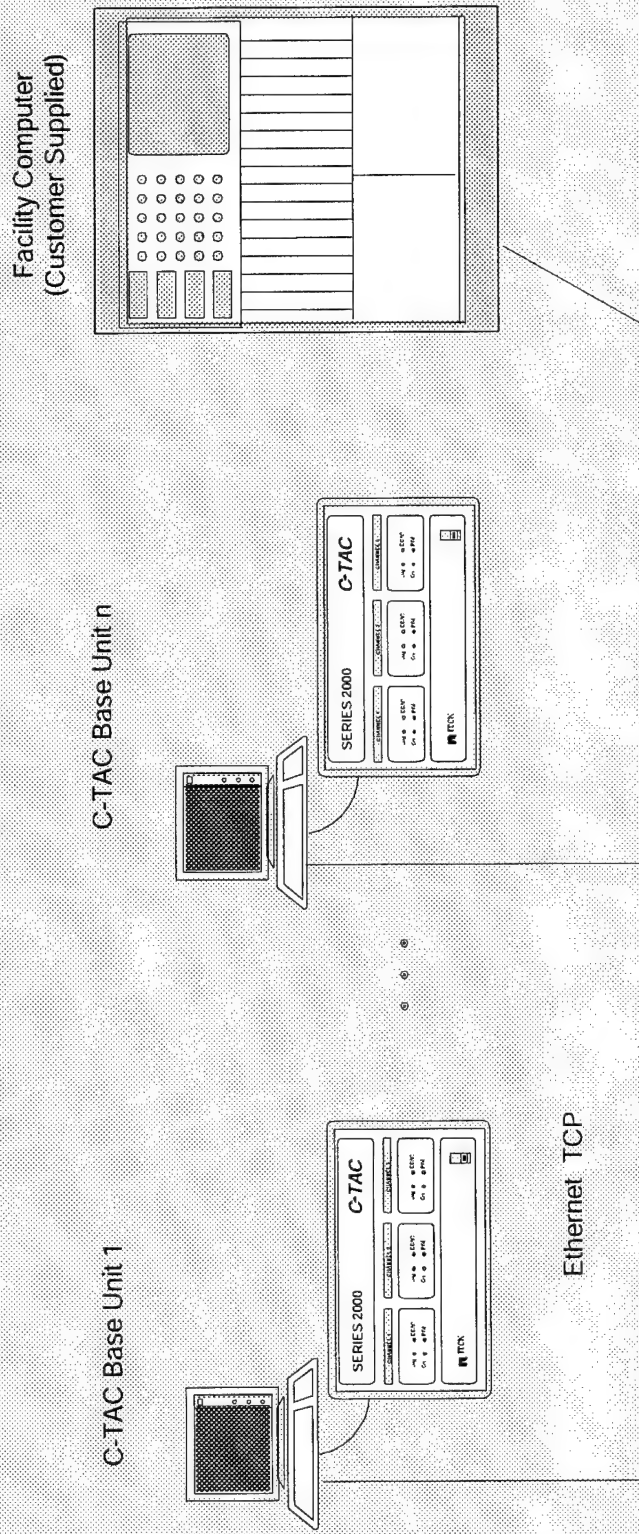
Write
Cancel

C-TAC Remote Workstation Software



- C-TAC Base Units cannot be used as standalone units when in the Remote Mode.
- Software is provided to reconfigure the C-TAC Base Units to Standalone Mode.
- Optional C-TAC equipment required.

C-TAC Remote Control Software



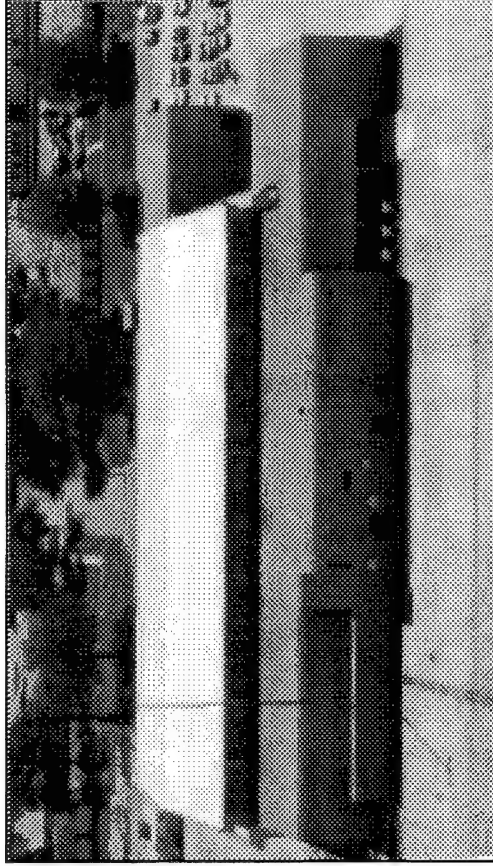
Note:

Not all commands are supported on all targets
Optional C-TAC equipment required
Customer supplied facility computer required

- Load C-TAC specification files
- Download to target memory
- Start / Stop monitor
- Run / Halt target
- Upload captured data
- Read / Write target memory
- Read / Write target registers



PRIMES



PREFLIGHT INTEGRATION OF MUNITIONS AND ELECTRONIC SYSTEMS

46 TW/TSWW
Michael Deis
DSN 872-9354 X-222
deis@eglin.af.mil

9/1/98



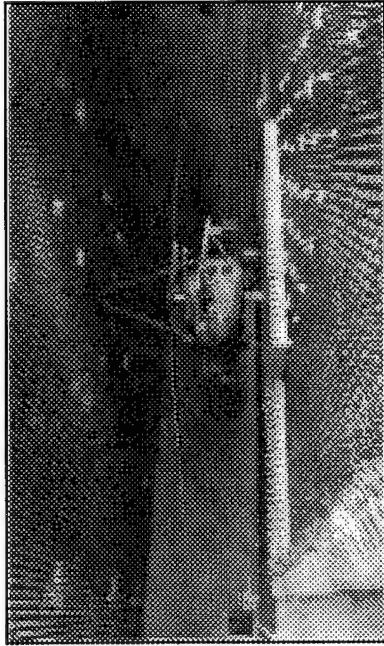
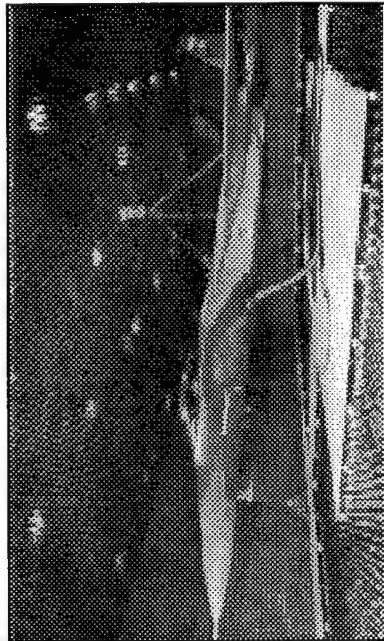
TOPICS



- Facility Overview
- Sensor Passive Ranging Test Capability
- AIM-9X JHMCS Integration Test Capability
- Polarization Measurement and Simulation Test Capability
- F-15/APG-70 Radar Interface Adapter
- Target Radar Cross-Section Model
- F-15/F-16 Munitions Ballistic Modeling



CHAMBER TESTING

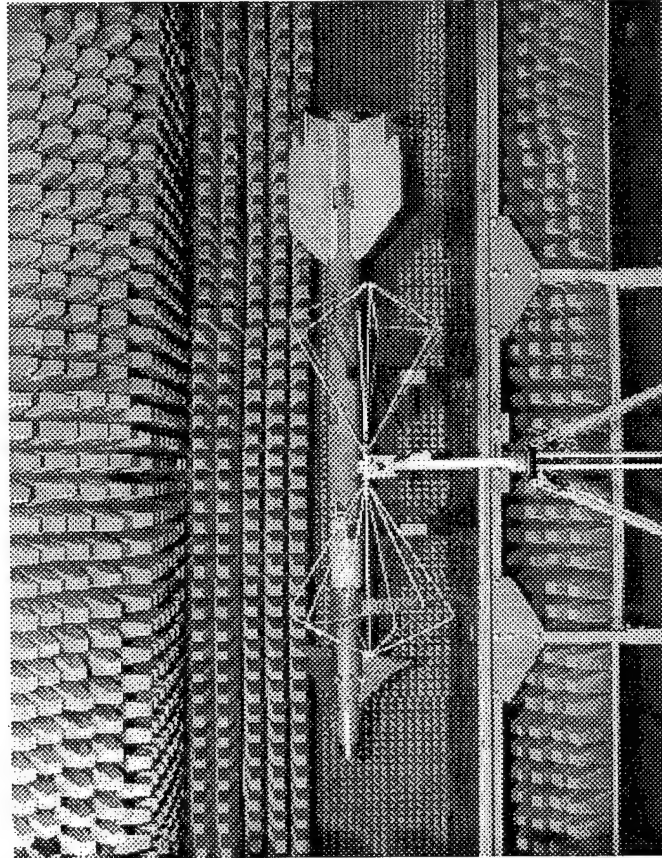


- FULLY ANECHOIC WITH 74' X 104' X 26' WORKING VOLUME
 - 20' X 66' DOOR & 40 TON HOIST
- 100 dB RF ISOLATION
- FOR SYSTEM-LEVEL EMC TESTING PER MIL-E-6051, ETC
- EXTENSIVE INSTRUMENTATION FOR REMOTE MONITORING & STIMULATION OF ON-BOARD SYSTEMS
- PRIMES ADDITIONAL SUPPORT CAPABILITIES
 - EMI/EMC DESIGN AND PROGRAM SUPPORT
 - MODELING & SIMULATION/SOFTWARE DEVELOPMENT
 - CONSULTATION ON OTHER E3 DISCIPLINES SUCH AS ESD, EM HAZARDS, LIGHTNING & TEMPEST
 - OFF-SITE MEASUREMENTS SUCH AS EM AMBIENTS
- ELECTRICAL, HYDRAULIC, AIR CONDITIONING UTILITIES AVAILABLE

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EMI/EMC LABORATORY



12' X 24' X 8' SEMI-ANECHOIC SHIELDED ENCLOSURE

- PROVIDES UNIT OR SUBSYSTEM LEVEL EMI TESTING
- FERRITE TILES & ANECHOIC CONES FOR LOW & HIGH FREQUENCY ATTENUATION
- 16' COPPER-TOPPED TEST BENCH AND FILTERED POWER

NVLAP ACCREDITATION THROUGH NIST, NARTE CERTIFIED EMC ENGINEER
RADIATED/CONDUCTED EMISSIONS & SUSCEPTIBILITY

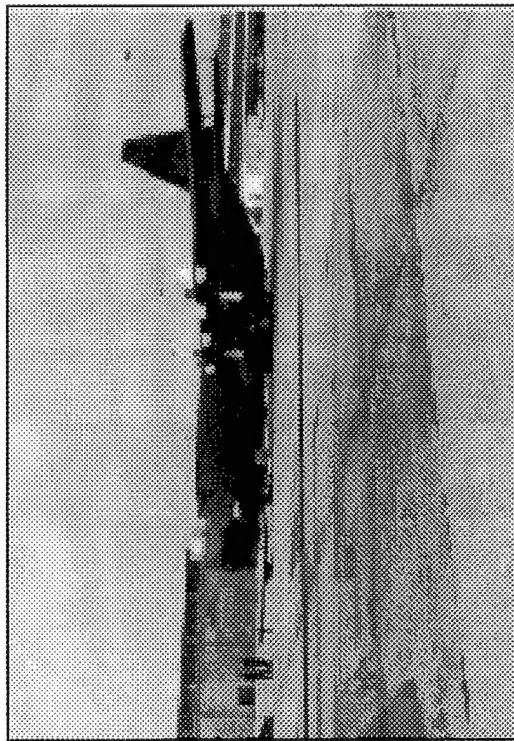
- ESTABLISHED FOR MIL-STD-461/-462 TESTING
- CAPABILITIES ENCOMPASS MANY OTHER EMI SPECS
- RADIATED CAPABILITIES FROM 30 Hz TO 40 GHz

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1191



LARGE AIRCRAFT RAMP TESTING



- OUTDOOR TEST AREA
- RADIATED TESTING AVAILABLE
- ACCESS TO ALL FACILITY
SIMULATION AND INSTRUMENTATION
CAPABILITIES
- ANTENNA PATTERN MAPPING



SENSOR PASSIVE RANGING TEST CAPABILITY



- Dynamic line-of-sight target simulation
- RF, 0.5-20 GHz, radiated free space simulation
- Supports aircraft sensor and munitions seeker tests
- 6 degree-of-freedom target and sensor motion
- Measures passive ranging algorithm performance
- Supports situation awareness and sensor fusion
- Parallax error compensation



AIM-9X JHMCS INTEGRATION TEST CAPABILITY



- 6 DOF motion simulation of F-15 and the missile target
- Visual cueing to target aircraft
 - Laser spot on ceiling and side walls of chamber
 - Represents the LOS angle from cockpit to target
- Fire control radar cueing performance
- Missile umbilical instrumentation
- EMI/EMC system testing
- GWEF-PRIMES Link

9/1/98

1194



POLARIZATION MEASUREMENT AND SIMULATION TEST CAPABILITY



- RF, 0.5-20 GHz, radiated free space
- Measures all polarization parameters of antennas
- Simulates all polarization characteristics of antennas
- Tests next generation receivers and antenna discriminates
- Tests DF sensitivity of monopulse antennas



F-15/APG-70 RADAR INTERFACE ADAPTER



- Timing signal interface between APG-70 radar and PRIMES target generator
- Will support Suite 3 & 4 OFP tests
- Funded by F-15 program office (\$800K)
- Design upgrade path for APG-63V1 interface

9/1/98



TARGET RADAR CROSS SECTION MODEL



- CAD-based, ray analysis model
- 10 GHz target frequency at far-field range
- Database model for PRIMES target generator
- Target models include QF-4E and blue fighters

9/1/98

1197



F-15/F-16 MUNITIONS BALLISTIC MODELING



- Tests CCIP and CCRP avionics functionality
- Will support F-16 Block 40 Tape 6 tests
- Initial models include MK-82 AIR, MK-82 and PGU-28
- Tests SMS and PACS functionality
- Test EGS functionality

9/1/98

1198



ELECTRONIC COMBAT INTERNATIONAL
SECURITY ASSISTANCE PROGRAM



ECISAP WR-ALC/LNI

Presented by:

Mike Morris

WR-ALC/LNIE



LNI MISSION ORIENTATION ECISAP MISSION



WARFIGHTERS

PLANNING

DEVELOPMENT

SUSTAINMENT

EW REPROGRAMMING

REPAIR

MODS/TECH INSERTION

PROGRAM MANAGEMENT

ENGINEERING

LOG MANAGEMENT

ECISAP

- Structure
- Mission
- Staffing
- Facilities
- Advantages

ECISAP STRUCTURE

- **USAF Management Concept**
 - *EC single management focal point*
 - *Initial installation & follow-on support*
 - *EW standardization and interoperability for ECISAP member nations*
- **Managed by SAF/IA**
 - *USAF International Affairs oversight*
 - *AFI 10-703*
 - *AFMAN 16-101*

ECISAP STRUCTURE

- ECISAP Executive Agent: WR-ALC/LNI
(International Logistics Division,
Electronic Warfare Directorate)
 - *Coordinate ECISAP efforts among key
administering agencies such as:*
 - AF/XOIO HQ ACC/DOSS
 - SAF/IA 68 ECG
 - AFSAC AFIWC
 - AF/XOIIIF AFSAT
 - Other agencies as determined by the LOA

ECISAP STRUCTURE

- Executive Agent (continued)
 - *Coordinate Pricing & Availability (P&A) data and Letter of Agreement (LOA) input*
 - Establish Military Articles and Services List (MASL) line item on system sale LOA
 - Individual LOA
- Two Types of Membership
 - *Full service (software and hardware)*
 - *Technical Support only*

ECISAP MISSION

- Single Focal Point for EC FMS and Security Assistance Systems
 - *Initial (pre-aircraft delivery)*
 - *Follow-on (post-aircraft delivery)*

ECISAP MISSION

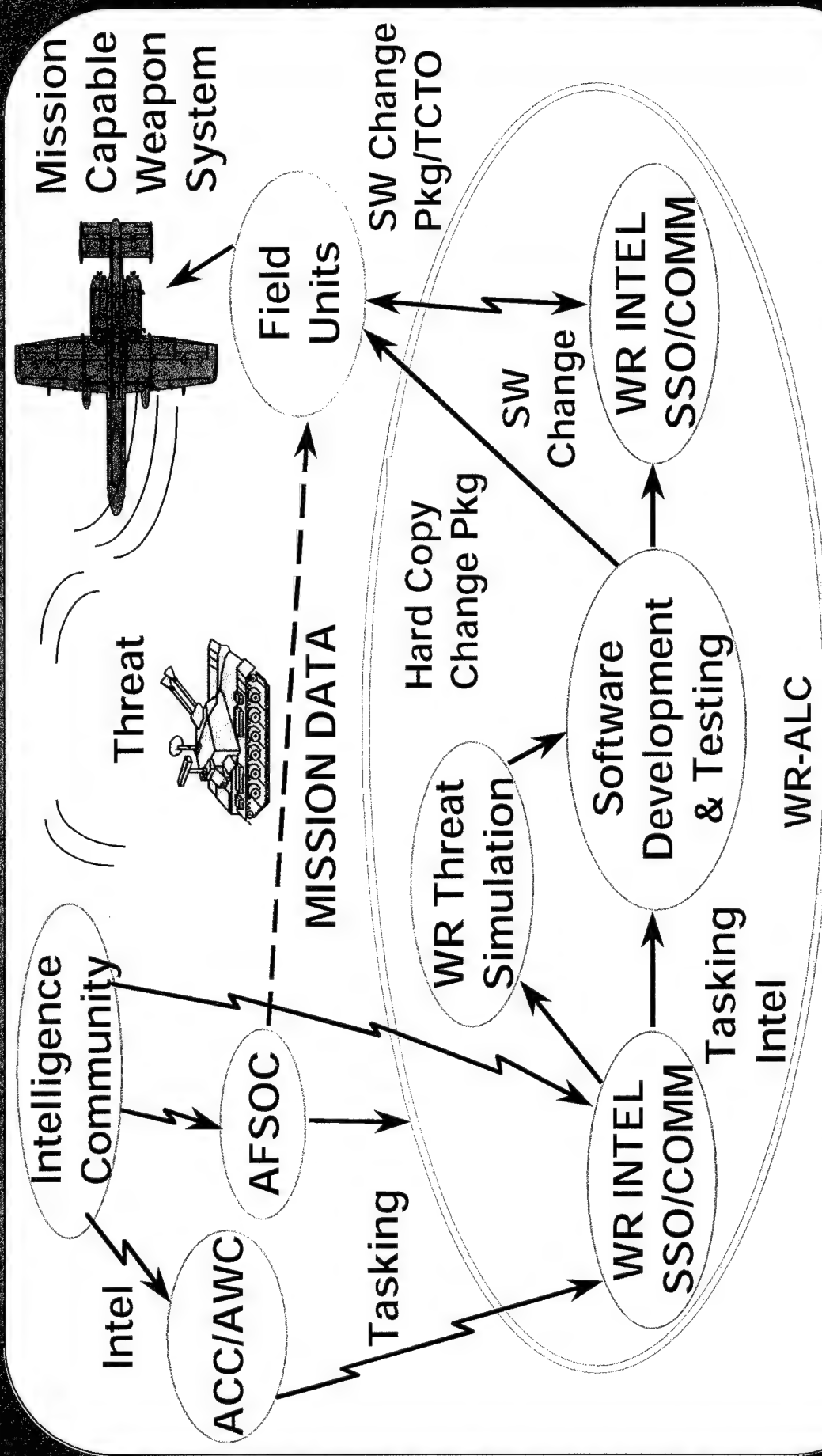
- Provide System Support
 - *Hardware deficiencies/enhancements*
- Provide System Software Support
 - *Operational Flight Program*
 - *Mission data or threat data*
- Provide Rapid Reprogramming Capability

ECISAP MISSION

- Provide Technical Services and Assistance
- Provide Country Standard Technical Orders
- Provide Configuration Management
- Provide Kitproofing of Software Updates

ECISAP

EW SOFTWARE CHANGE CYCLE

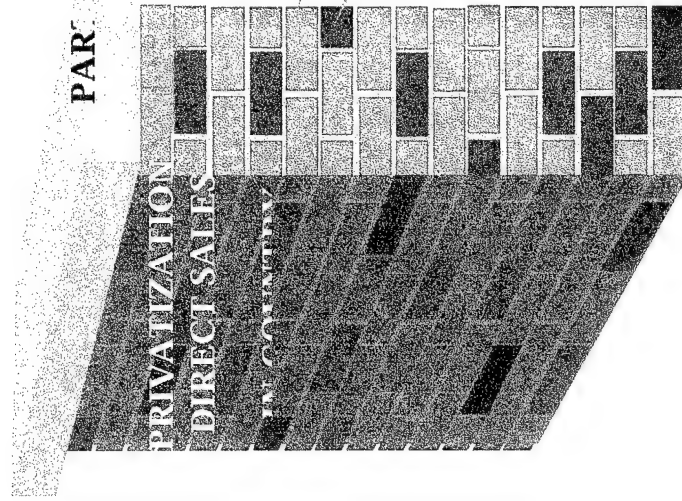


Emergency Reprogramming + Routine Block Cycle Updates

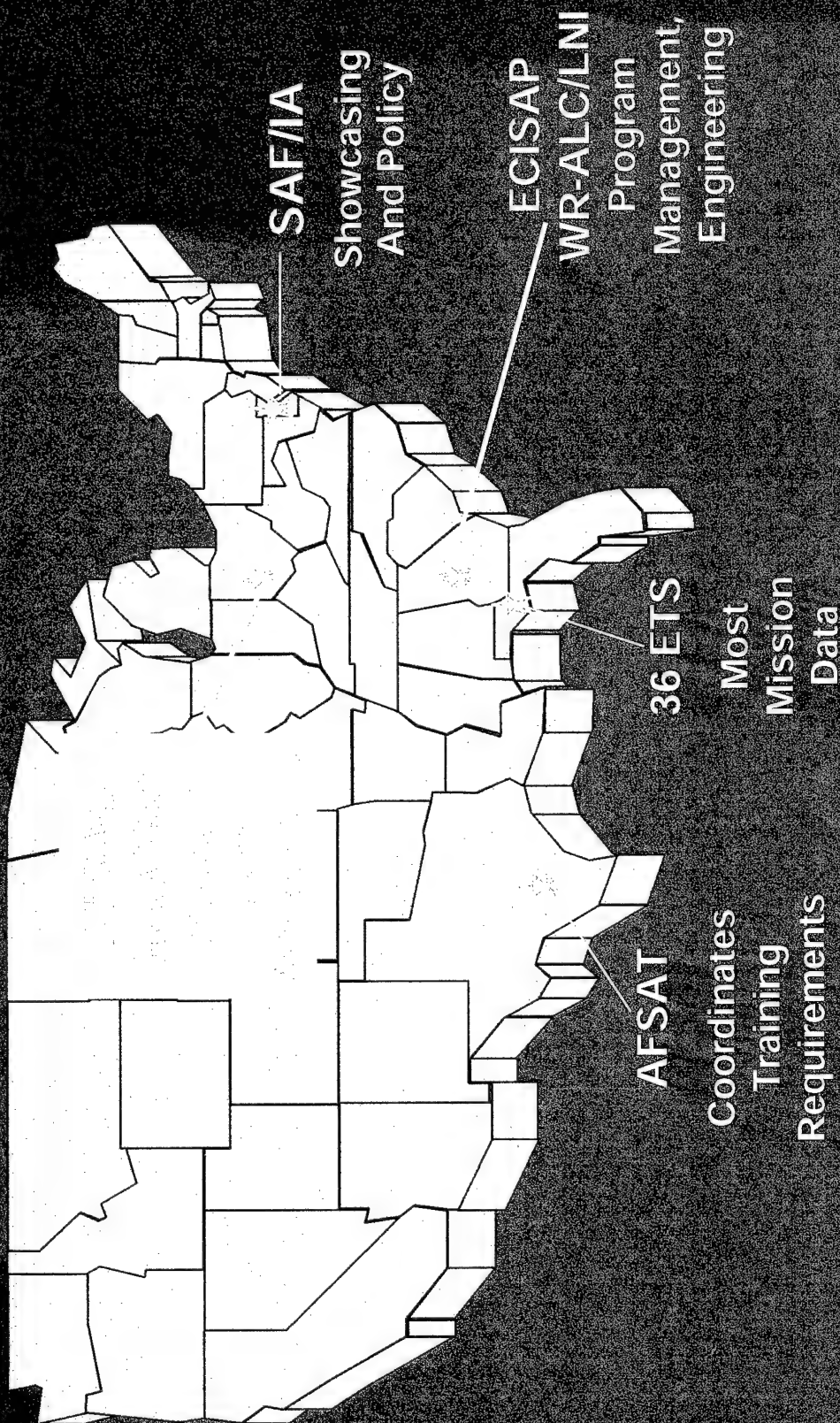
ECISAP/LNI APPROACH

LNI's INDIRECT APPROACH

VISION --
To Become The



ECISAP FUNCTIONAL SNAPSHOT



ECISAP ORGANIZATION

DEPUTY UNDER SECRETARY OF THE AIR FORCE
(SAF/IAW)

HQ ACC
(DOSS)

HQ USAF
(XOIF)

HQ USAF
(AFSAT)

AFMC
(AFSAC)

36 ETS

WR AIR LOGISTICS CENTER
(LN)

INTERNATIONAL LOGISTICS DIVISION
(LND)

ENGINEERING BRANCH
(LNIE)

INTEGRATED SYSTEMS TEAM
(LNIEA)

FLIGHT PROGRAM TEAM
(LNIEB)

MISSION DATA TEAM
(LNIEC)

ACTIVE JAMMER TEAM
(LNIED)

PROGRAM MANAGEMENT BRANCH
(LNIM)

PROGRAM MANAGERS

TECHNICAL SERVICES

ITEM MANAGEMENT AND
INVENTORY MANAGEMENT

TECHNICAL PUBLICATIONS

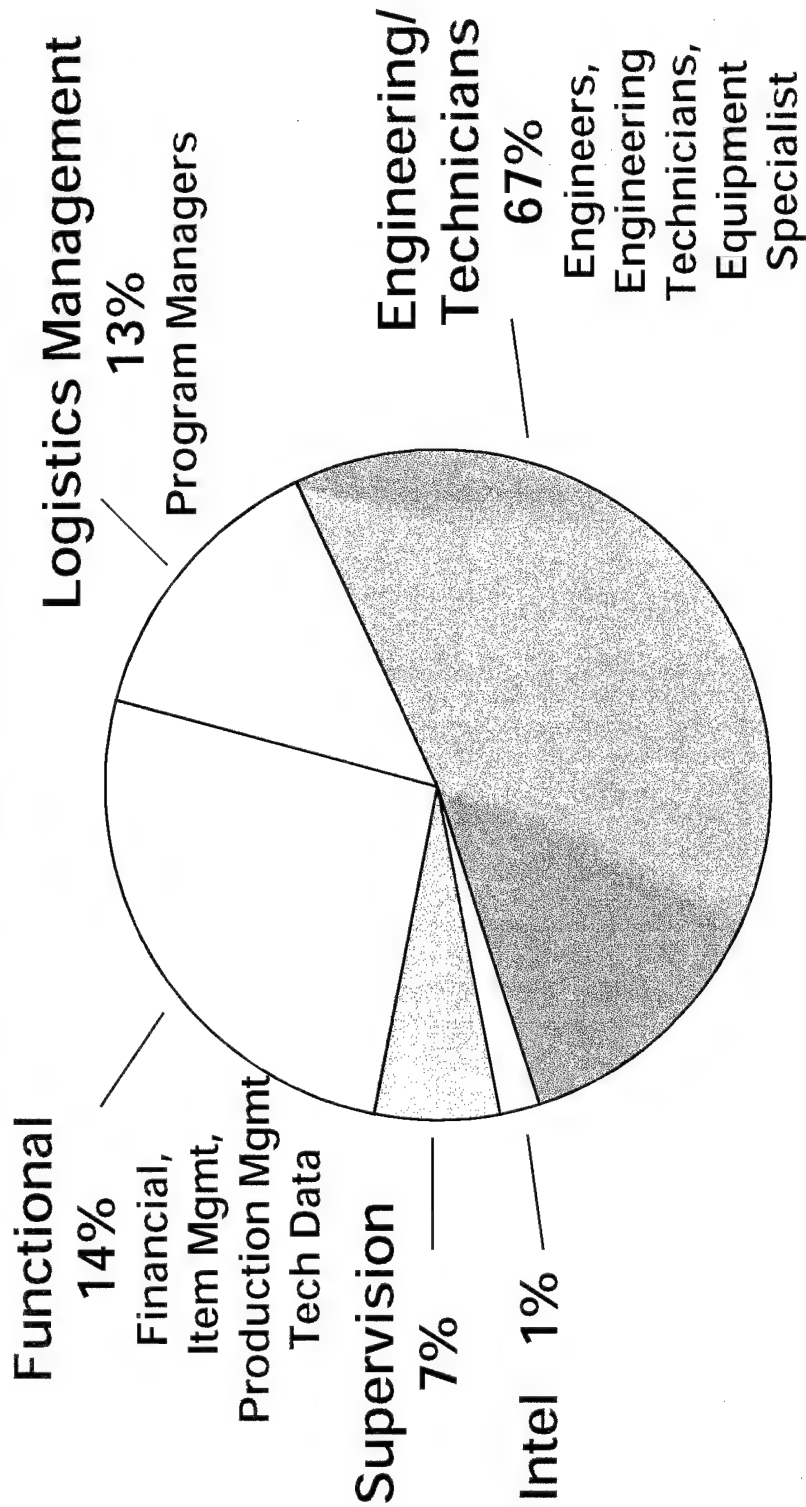
FINANCIAL MANAGEMENT

ECISAP/LNI STAFFING

- 92 Civilians/ 5 Contractors
 - *Engineering (GS-855s, GS-856s, GS-854s)*
 - *Program Management (GS-346s, GS-1670s, GS-2010s, GS-1087s, GS-344s)*
 - *Financial Management (GS-501s, GS-510s, GS-301s)*

ECISAP/LNI STAFFING

AUTHORIZATIONS	92
CONTRACTORS	5
PALACE ACQUIRE	1
TOTAL EMPLOYEES	<u>98</u>

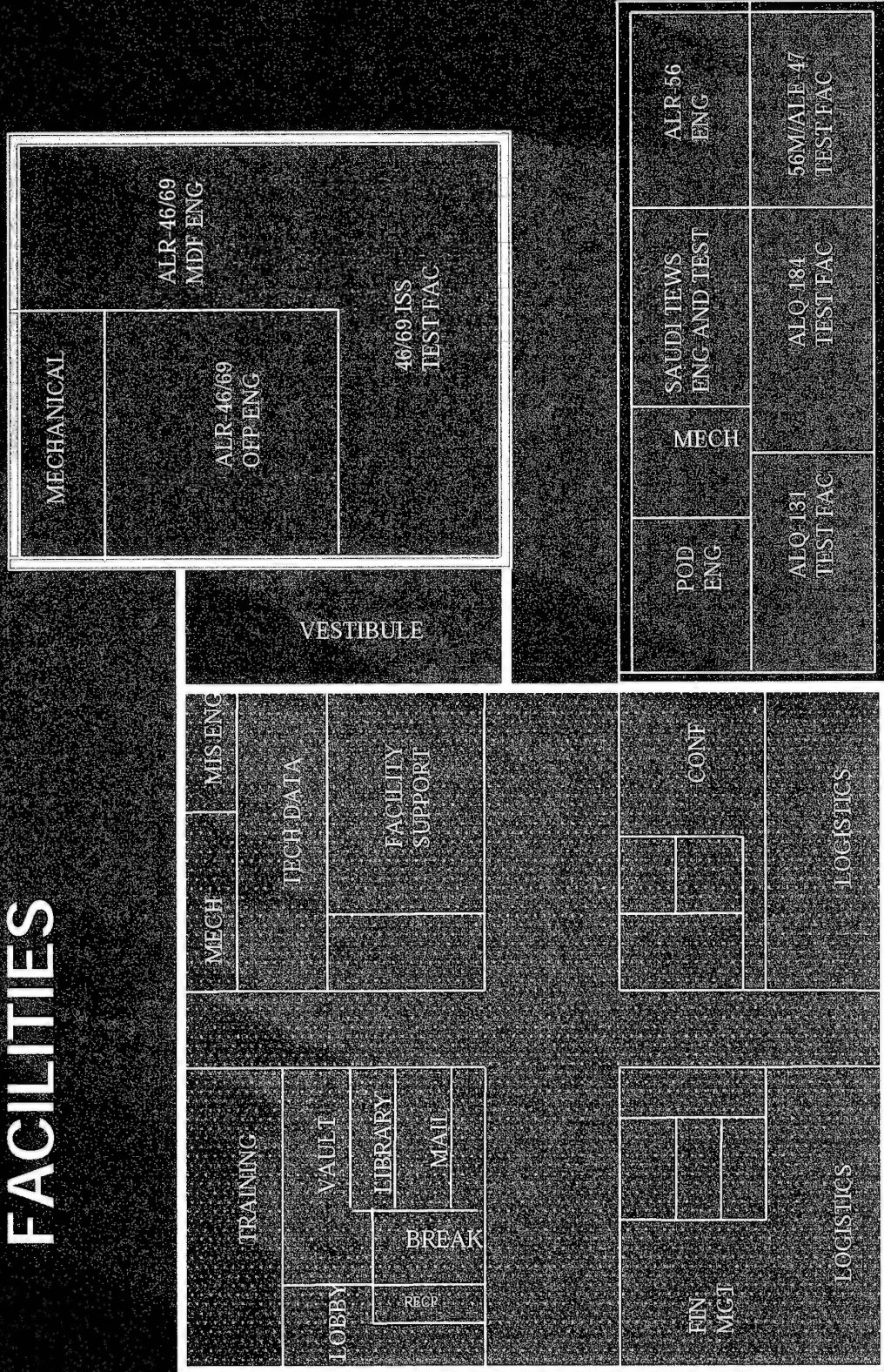


ECISAP/LNI FACILITIES

- NEARLY 43,000 SQ.FT. ELECTRONIC/COMPUTER WORK AREA (SECURE, TEMPEST & EMERGENCY POWER)
- 1 SCREEN ROOM
- SPECIAL ACCESS VAULT
 - Intelligence Data
 - Secure Communication Links
- 7 UNIQUE SYSTEM LABORATORIES
- 8 THREAT GENERATORS AND INTEGRATED SUPPORT STATIONS
- ✓ OVER \$30M INVESTMENT
- ✓ MOST CAPABLE AND PRODUCTIVE FMS EW FACILITY IN DOD

ECISAP/LNI FACILITIES

FACILITIES



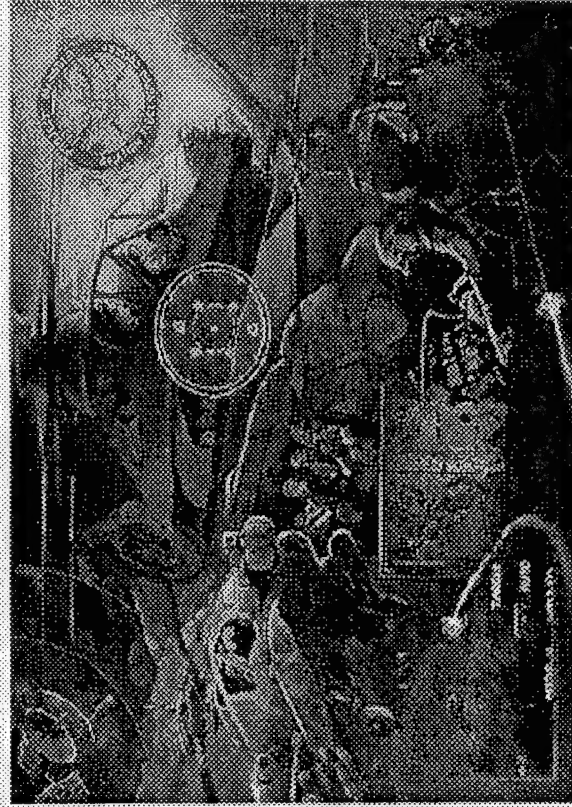
ECISAP

"TOP TEN" Advantages

- ECISAP Executive Agent/ Single POC for FMS
- Rapid Reprogramming
- USAF Made and Tested Standards
- US Government Intel Data Base
- Total System Support
- Dedicated Resources
- "At Cost" Services
- In-House Technical Publications
- On-site Depot Repair
- Established Capability for 2 Decades



Program Overview



Mr. Larry D. Johnston

PROJECT MANAGER
AVIATION ELECTRONIC COMBAT



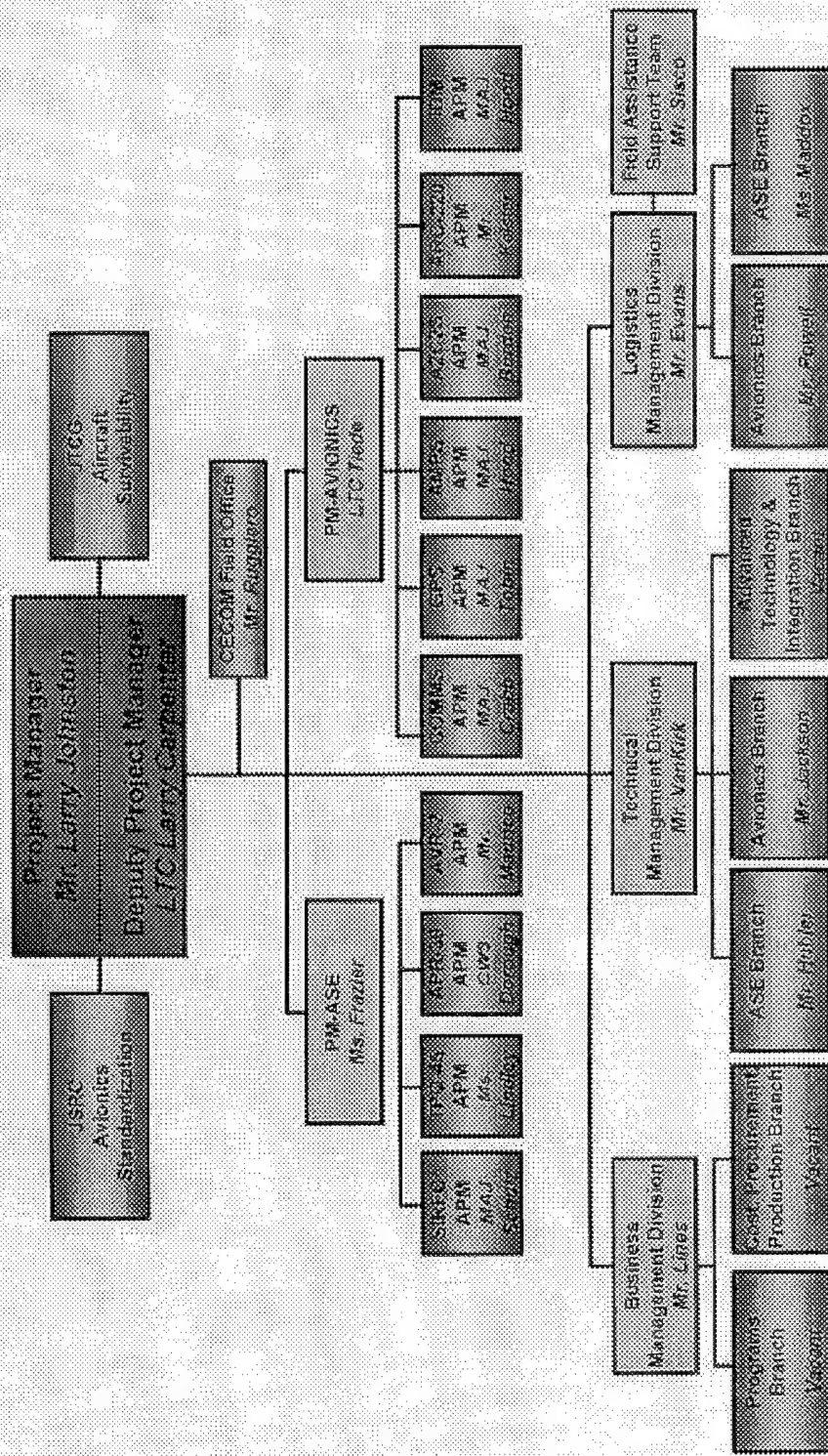
Vision



Provide the mission area leadership for determining the future technology direction and architecture for aviation electronics, while developing and producing the most capable, sustainable, and cost effective solutions for the warfighter.



Project Manager Aviation Electronic Combat ORGANIZATIONAL STRUCTURE





AMIDONES



AMIDONES (MILITARY) 1000 1000 1000



A black and white illustration of a windmill with a small house on top, set against a background of a city skyline. The windmill has four large blades and a small house with a chimney on its body. The city skyline is visible in the background, featuring various buildings and structures. The illustration is rendered in a simple, stylized manner.

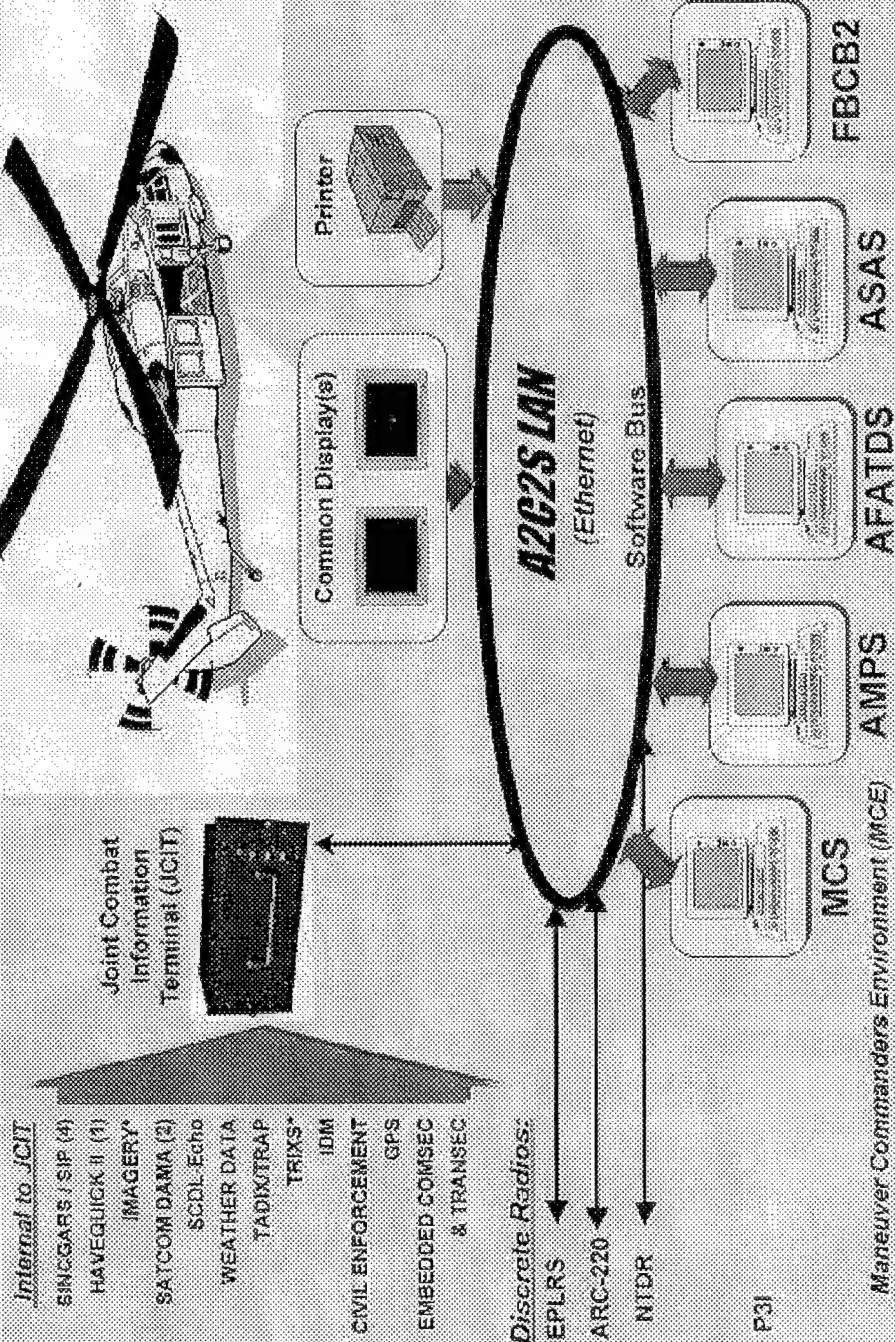
- ◆ Integrated on a UH-60 Blackhawk
- ◆ AAO 207 systems, 276 A kits
- ◆ Open systems architecture
- ◆ Five reconfigurable workstations
- ◆ Weight: 1200 lbs (Obj), 1800 lbs (threshold)

- ◆ **Airborne Tactical Command Post**
- ❖ Automates decision support systems
- ❖ Visual displays shorten sensor to shooter decision cycle
- ❖ Provides situational awareness through C-4 digital connectivity
- ◆ **Interoperable with other C2 systems**

FY98 FY99 FY00 FY01 FY02 FY03
 EMD
 DT / IOT&E
 Production
 MS III ▲
 LRIP
 Full Production



A2C2S Top-Level Architecture





Semi-Conference,
Forward Facing
Layout

© 2006 Blackwell Publishing Ltd, *Journal of Internal Medicine* 260: 101–108

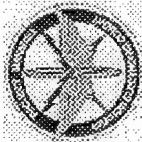
Hi-Resolution,
Large Screen Flat
Panel Displays

Wieder
begegnet man
Wieder

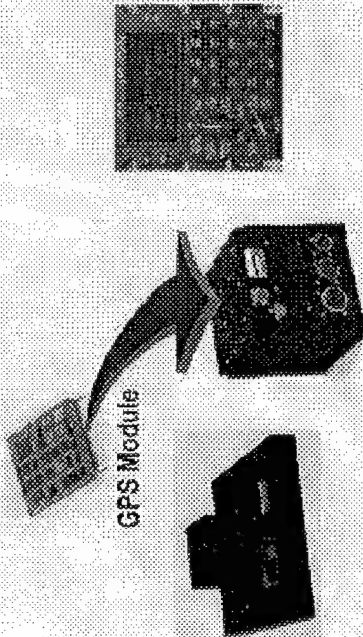
Centralized Workstation CPUs



© 2000 Blackwell Science Ltd *Journal of Internal Medicine* 247: 395–402



Doppler GPS Navigation System (DGNS)



GPS Module

Capabilities

- ◆ Utilize military P(Y) code
- ◆ Integrated with flight instruments
- ◆ Precise location (16m accuracy)
- ◆ 100 waypoints - AMPS loaded
- ◆ Universal timing
- ◆ GPS approach capability
- ◆ 4-line display, new controls

AS/NAV/OPS/NAV/OPS/NAV/OPS

Description

- ◆ Doppler Embedded GPS (DGNS)
 - ❖ Modified Doppler system
 - ❖ UH60/CH47
 - ❖ GPS module embedded in SDC
 - ❖ Can operate in either busserd or non-busserd integrations
 - ❖ Pure Doppler, GPS-only, and mixed navigation modes

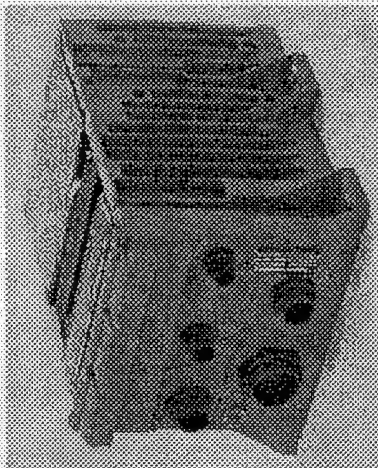
Schedule

DGNS	FY85	FY86	FY87	FY88	FY89	FY90
Integ/Test						
Installations						
Through FY98: 772 of 1780 field installations completed						

see 1



Embedded GPS - Inertial (EGI)



Capabilities

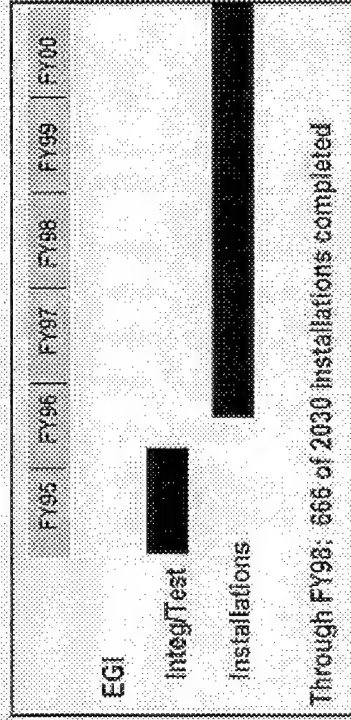
- ◆ Utilize military P(Y) code
- ◆ Precise location (16m accuracy)
- ◆ Precise velocity (INS - .8 m/s)
- ◆ Universal timing
- ◆ Integrated with on-board systems
 - ❖ Target acquisition
 - ❖ Situational awareness

AED/Scenarios/EGI/EGI.ppt 10

Description

- ◆ Embedded GPS Inertial (EGI)
 - ❖ 1553 Bus compatible
 - ❖ AH64A/D, OH58D, MH60K/L, MH47D/E, numerous AF, Navy aircraft
 - ❖ High MTBF: 6500 hours
 - ❖ Pure inertial, GPS-only and blended navigation modes

Schedule



12.16

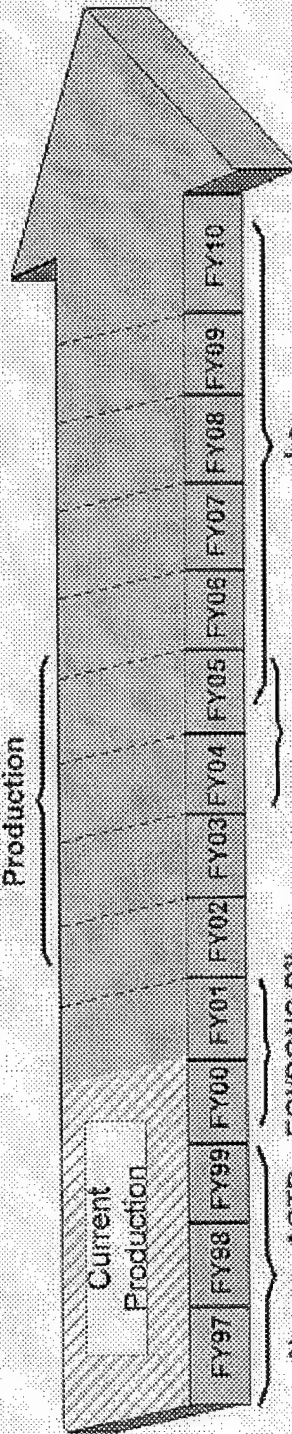


Strategy

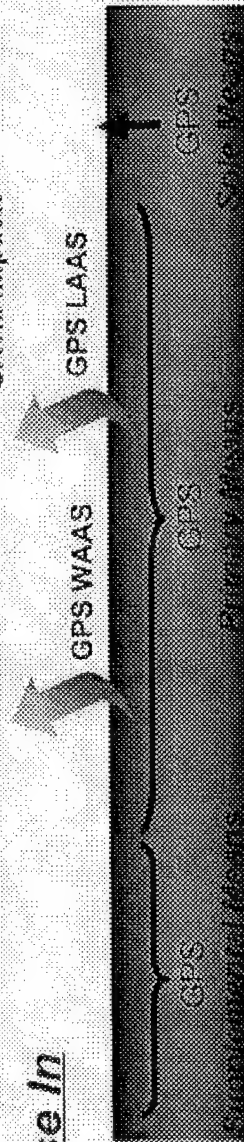
Phase Out



EGHDGNS P²¹
Production



Phase In

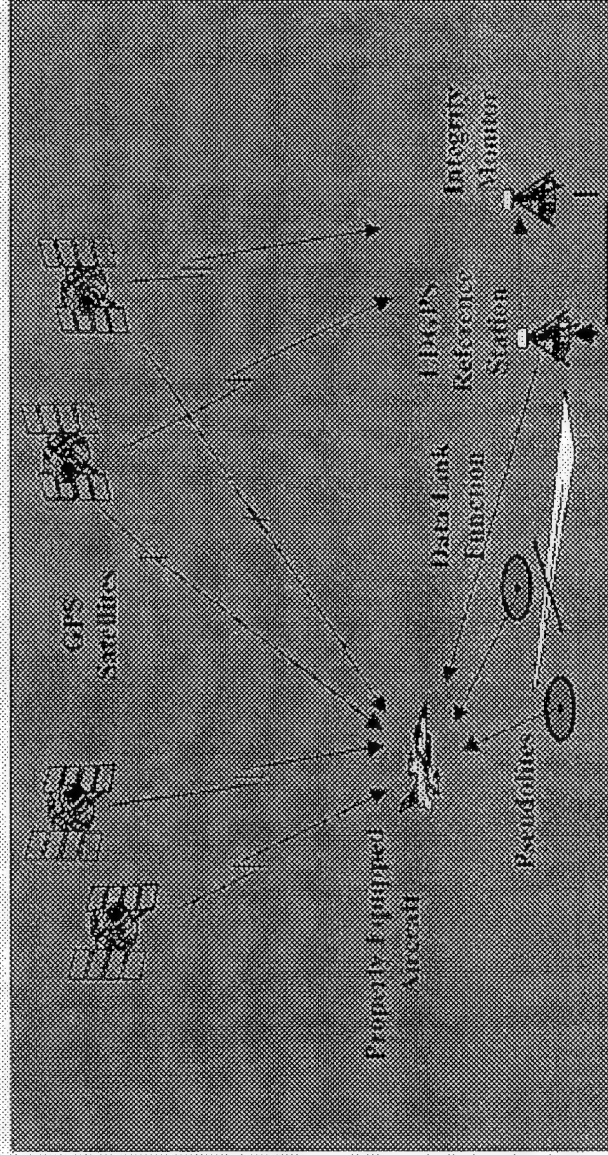


5



(Votoral)

- ◆ AoA completed 30 Aug 97
- ◆ Local Area Differential (LDGPS) determined to be most promising solution
- ◆ ACLS+ provided best shipboard redundant capability





The diagram illustrates the transition from current to proposed ATIS (Automatic Terminal Information Service) systems. A central aircraft is shown with various communication and navigation links.

Current System (Left Side):

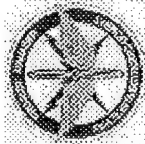
- Visual:** A dashed arrow labeled "VISUAL" points from a pilot's perspective (bottom left) to the aircraft.
- Radar & Sec Surv Radar:** A solid arrow labeled "MODE 3/A" points from the aircraft to the radar system (bottom right).
- ATC (Air Traffic Control):** A solid arrow labeled "UHF/HF/VE VOICE" points from the aircraft to the ATC system (bottom right).

Proposed System (Right Side):

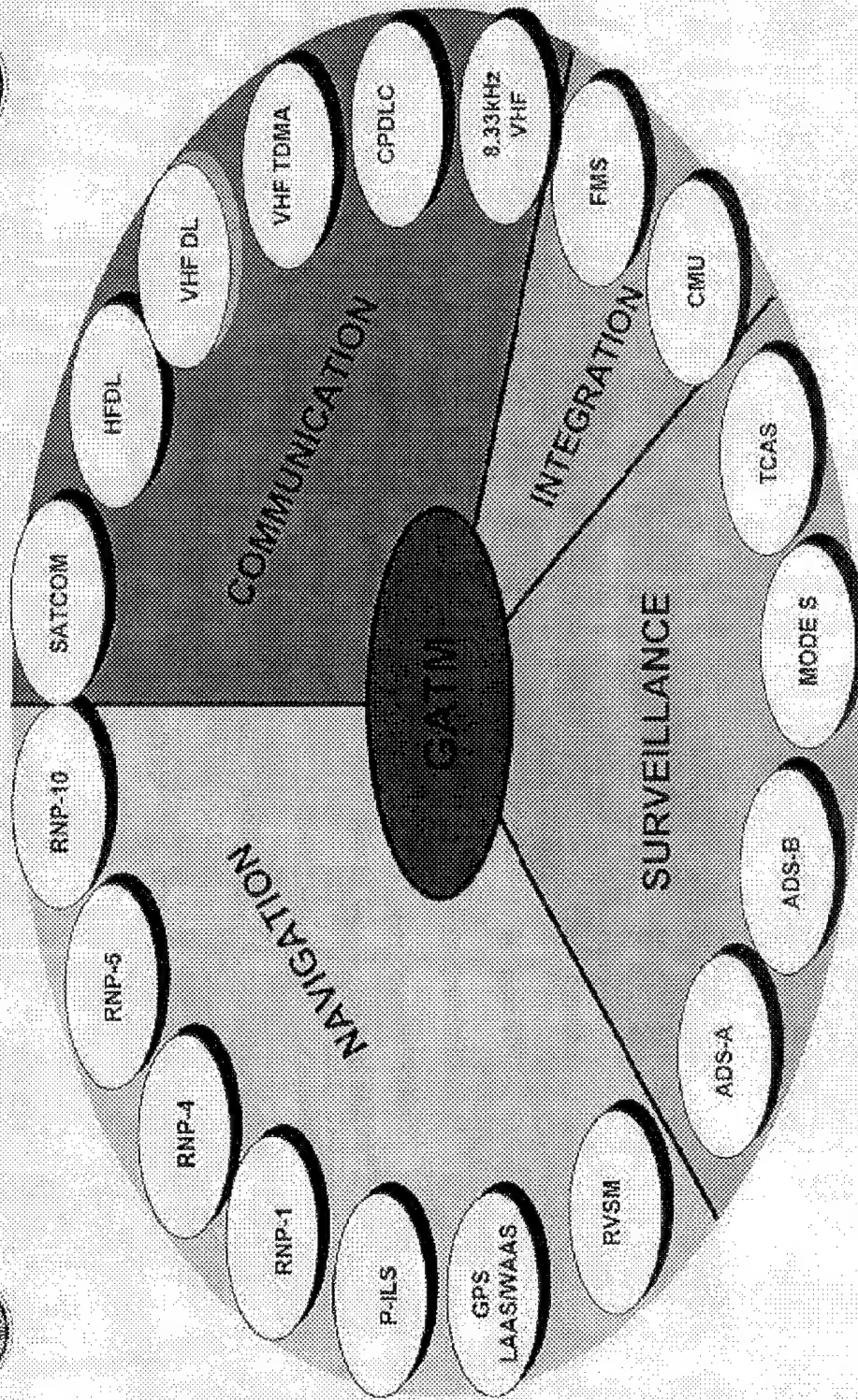
- CAS (Controller Area Surveillance):** A solid arrow labeled "MODE S (ADS-B)" points from the aircraft to the CAS system (top right).
- ATM (Air Traffic Management):** Two solid arrows point from the aircraft to the ATM system (top right): one labeled "POST/ID/VECTOR" and another labeled "ADS-B SELF-REPORTS".
- ATM (Air Traffic Management):** A solid arrow labeled "DATA/VOICE" points from the aircraft to the ATM system (top right).
- GPS (Global Positioning System):** A solid arrow points from a GPS satellite (top left) to the aircraft.
- TACAN OMEGA LORAN:** A solid arrow points from a navigation system (bottom left) to the aircraft.

A thick vertical line separates the "Current" and "Proposed" systems.

000

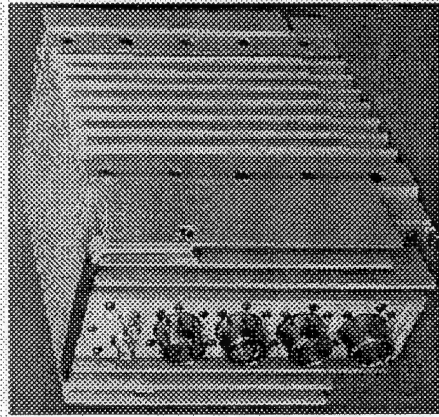


The GATM Universe





Improved Data Modem (IDM/EBC)



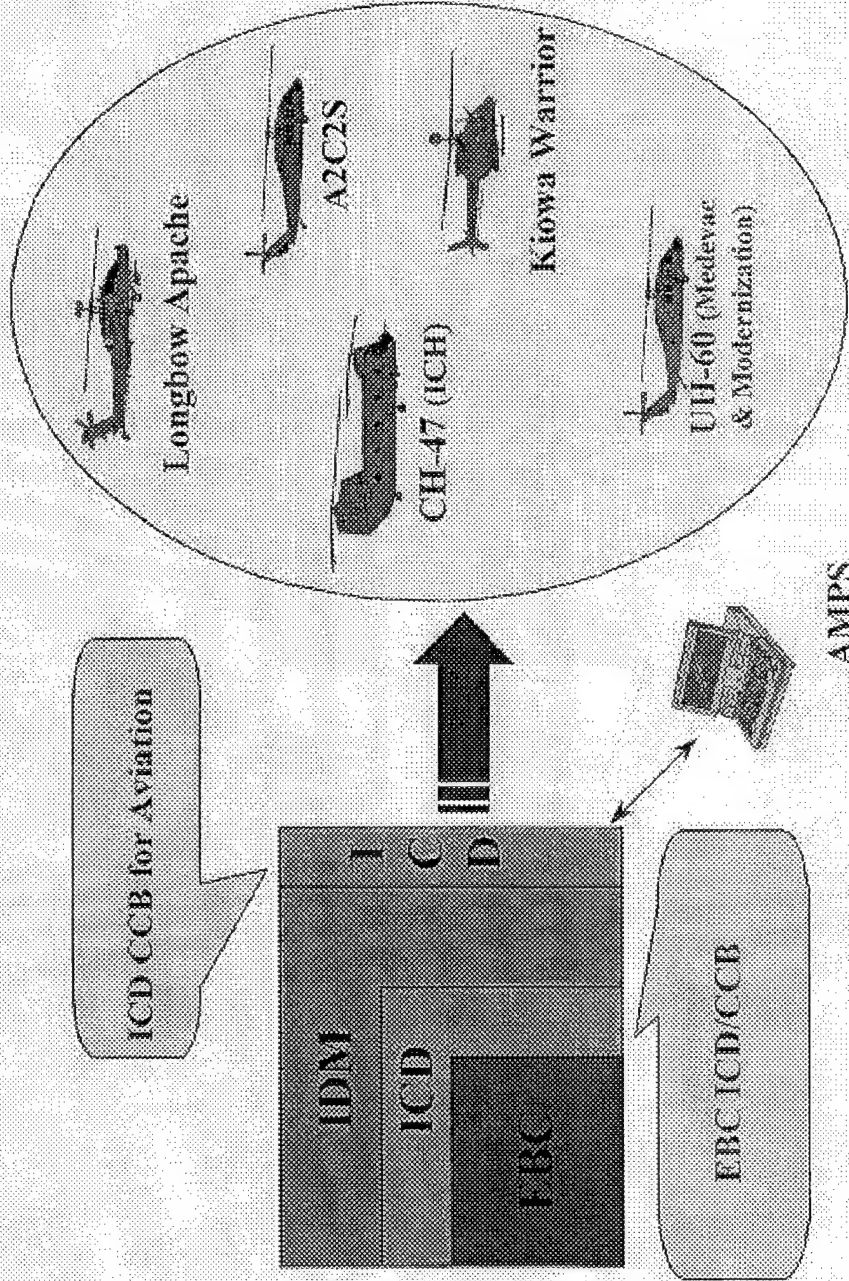
- ◆ Four channel transmit/receive terminal
- ❖ Each channel capable of analog, digital, or digital secure operations
- ◆ Processes multiple protocols and message sets (AFAPD, JVMF, AFATDS)
- ◆ Embedded battle command
- ❖ Pentium processor, 32mb RAM, 100mb mass memory

Capabilities

- ◆ Common multi-service aviation modem
- ◆ Provides message buffering
- ◆ Performs as aviation's Internet Controller (INC)
- ◆ Hosts EBC software to assure battlefield connectivity
- ◆ Protects mission computers from changes to message formats



ICD CCB for Aviation

[illegible]

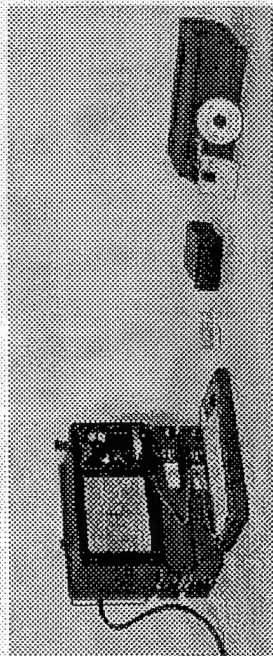


Aviation Mission Planning System



Description

- ◆ Planning/battle synchronization tool, which automates aviation mission planning tasks
 - ❖ Route generation
 - ❖ Performance planning
 - ❖ Communications planning
 - ❖ Terrain analysis
 - ❖ Data transfer
- ◆ Acquisition strategy follows evolutionary acquisition guidance
- ◆ BOIP: 2 per Avn Bde/Bn HQ, 1 per line Avn Co/Trp



Capabilities

- ◆ **Overlays / Military Symbols**
- ◆ **Hazards Locations**
- ◆ **Threat Intervisibility**
- ◆ **Operations Order Preparation**
- ◆ **Route / Aircraft Performance Planning**
- ◆ **Reduced Mission Planning Time**

Schedule

	FY96	FY99	FY00	FY01	FY02	FY03
SW Dev/Spt						
• DT						
• IOT&E						
Fielding						

22

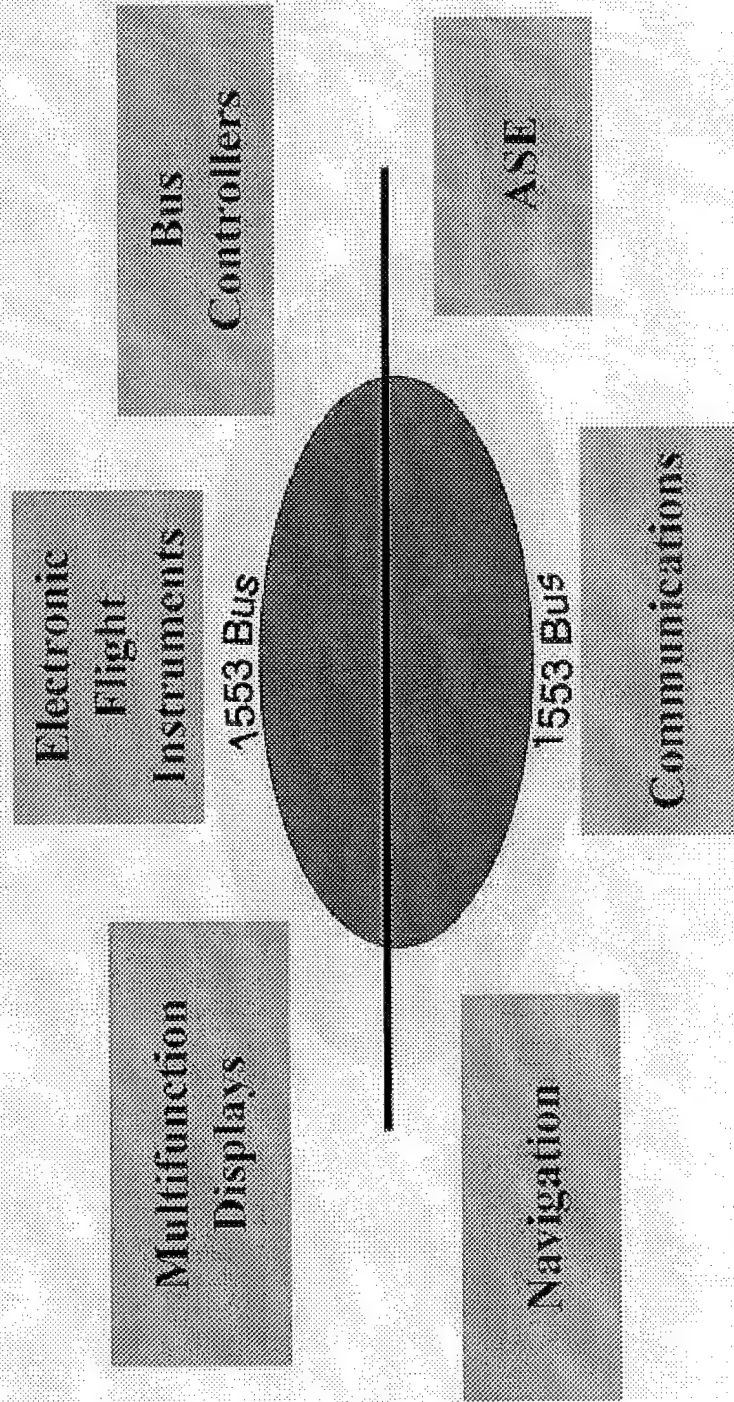


A collection of various metal fasteners, including buttons, buckles, and decorative pieces, arranged in a grid-like fashion. The items are displayed against a dark background, highlighting their intricate designs and textures. The fasteners include circular buttons with different patterns, rectangular buckles with ornate details, and several decorative metal pieces with complex, possibly embossed or engraved, designs. Some pieces appear to be part of a larger assembly or a set of components.

96 10022008.003 9605 11/20/08 0654



Commonality





Why Common Avionics Cockpit



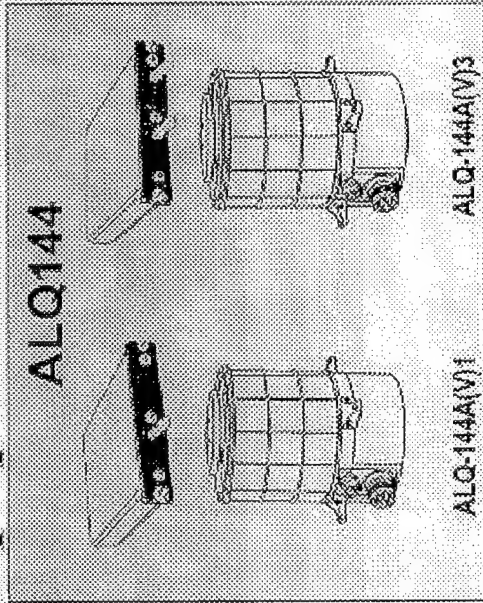
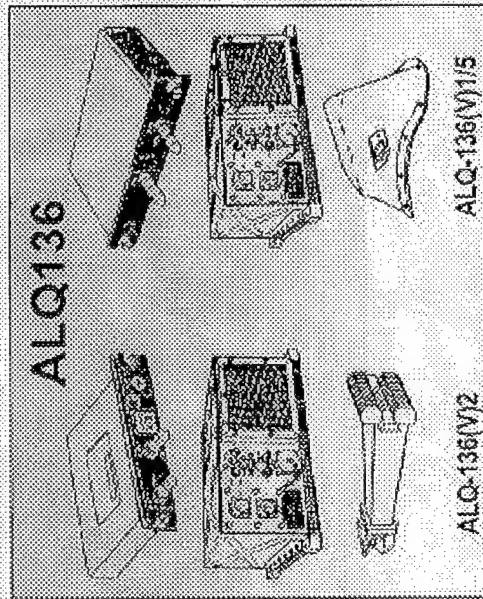
- ◆ Aircraft Have Common Operational/Functional Requirements
- ◆ Affordability- Reduces Life Cycle Cost
 - ❖ Reduced logistic support and training cost
 - ❖ Provides economic order quantity
 - ❖ Allows Common HW/SW Development
- ◆ Promotes Common HW/SW Upgrades
- ◆ Single Solution for Digitization/Situational Awareness (JTA-A Compliance)
- ◆ Heads Aviation Toward Open System Avionics
- ◆ Establishes Common Integration Path of Advanced Capabilities (SIIRCM, SIRFC, JCIT, AATI)

[illegible]

27



Fielded Aircraft Survivability Equipment



AFED/Comms/Int/Sec/Avionics/000, Apr 98

1721



ASE Evolution



The threat is global Red, Blue, and Gray Systems

Multi Mode
Complex CCM

Complex
Multi Spectrum

Today's
Federated
Systems

RWR

Pulse Jammer

CW Jammer

Threat Voids ?

S I R F C

TOMORROW'S

Advanced
Countermeasure
Suite

- Integrated Response
- Broad Spectrum Coverage
- High I/S
- CCM Resistant
- Multiple Threat Response

Today's
Federated
Systems

Missile Warning

IR Jammer

Dispense

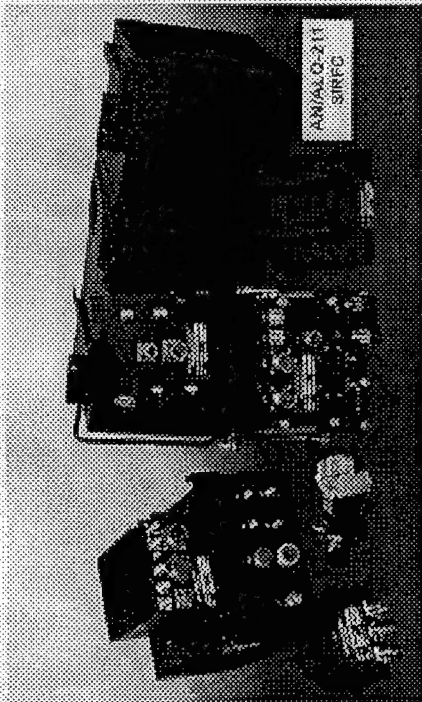
Threat Voids ?

S I I R C M

AVR-2A
Laser Warning



Suite of Integrated RF Countermeasures (SIRFC)



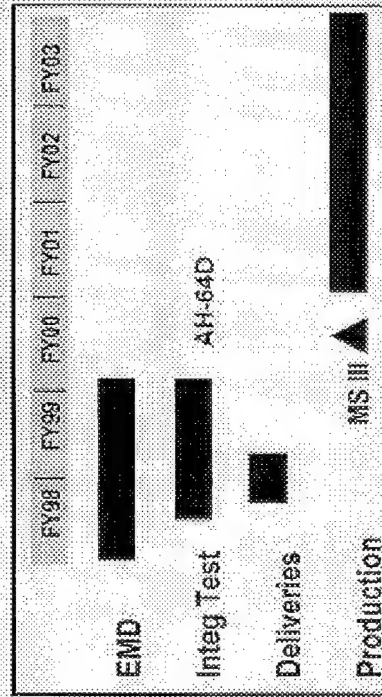
Description

- ◆ Integrated RF countermeasures suite
- ◆ RWR and RF ECM
- ◆ Replaces current RF ASE
- ◆ APR-39, ALQ-162, ALQ-136
- ◆ 4 LRUs - Total weight 97 pounds

Capabilities

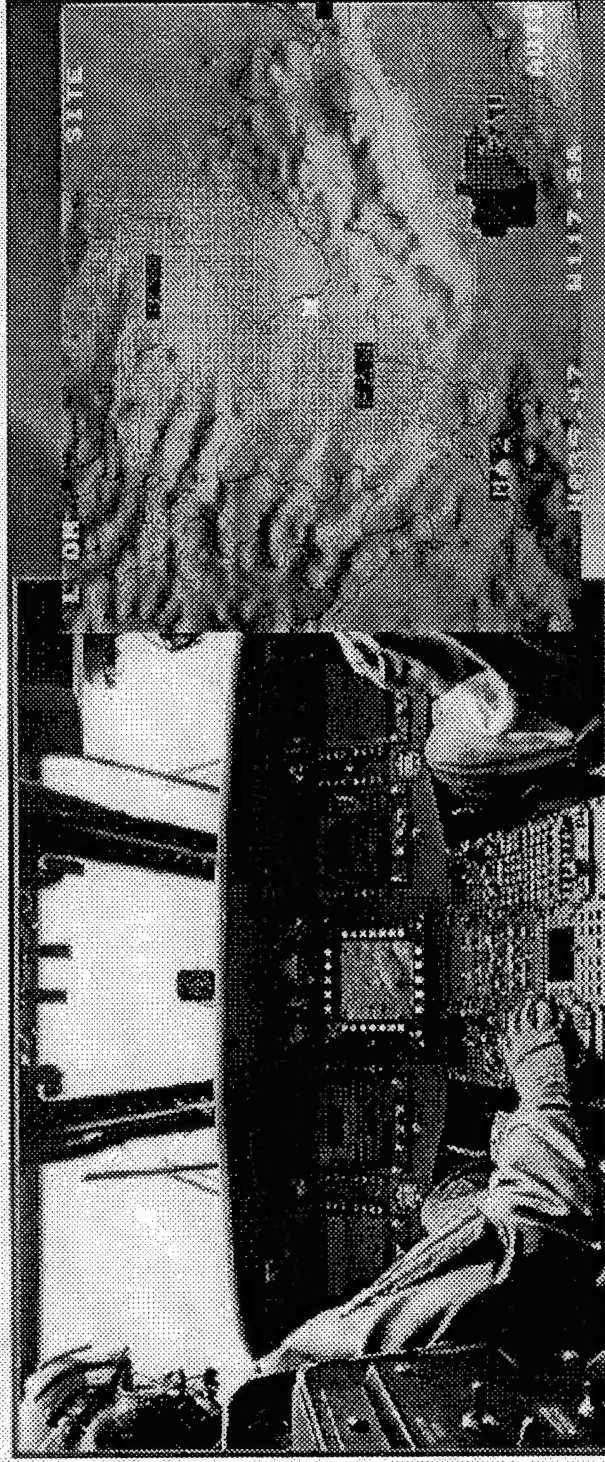
- ◆ RF Sensor/Jammer
- ◆ Sensor Fusion Processing
- ◆ Integrated Response Management
- ◆ Broad Spectrum Coverage
- ◆ Accurate Threat Location
- ◆ Multiple Threat Response

Schedule





Advanced Situational Awareness & Self-Protection



- ◆ Displays threat data to aircrews on digital moving map
- ◆ Disseminates data to other airborne platforms & ground forces through command and control network

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AN/ALQ-212

Suite of Integrated IR Countermeasures

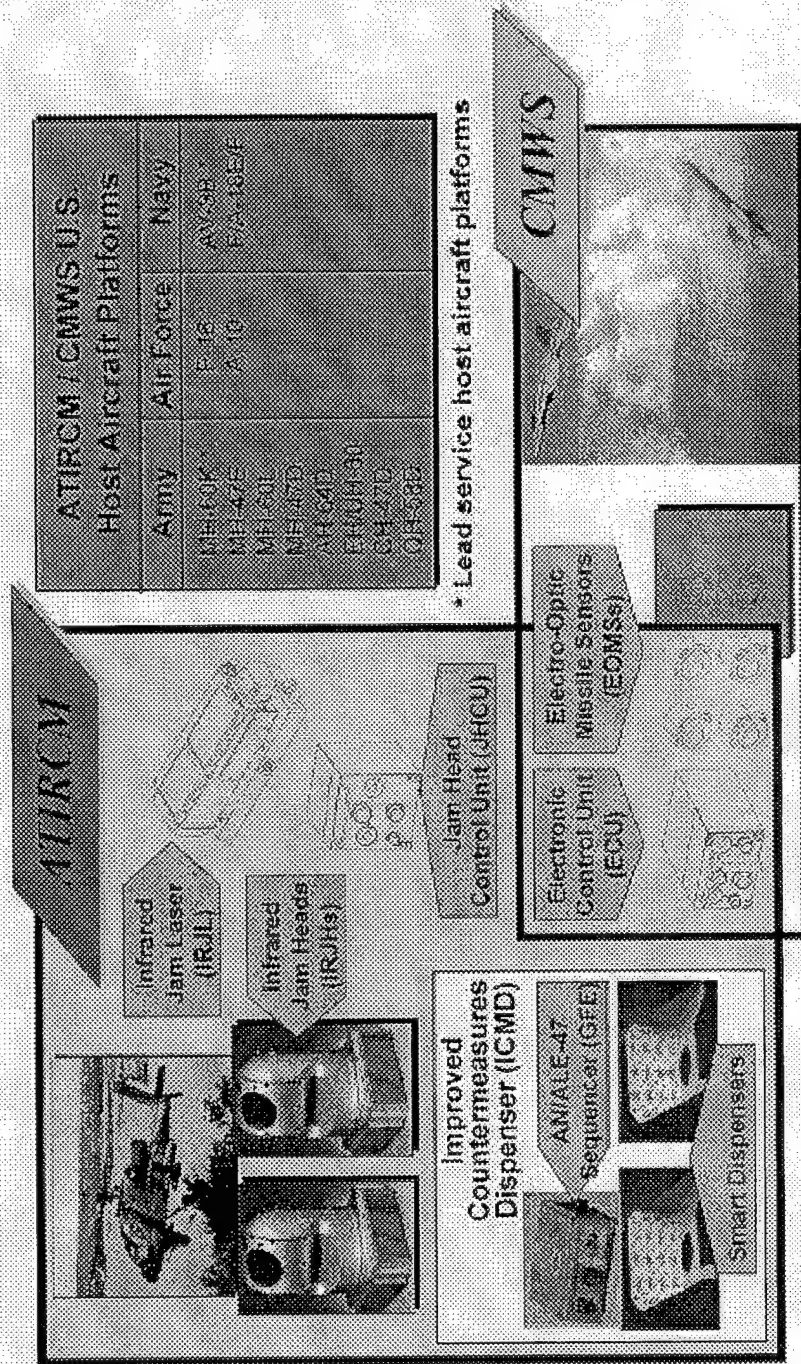


AN/ALQ-212 (Suite of Integrated IR Countermeasures)

10/42

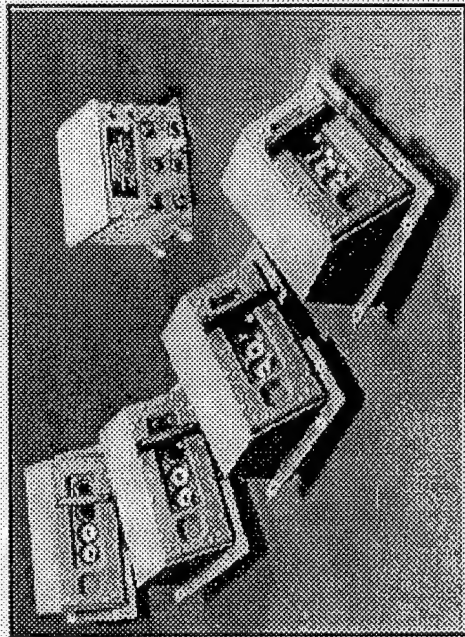


ATIRCM / CMWS





AVR-2A(V) Laser Detecting Set



Description

- ◆ Provides warning to Aircrew of laser aided weapons via APR-39
- ◆ 4 sensors mounted on aircraft surface, 1 interface unit mounted internally
- ◆ Wide coverage and high sensitivity

Capabilities

- ◆ Detects laser weapons
- ◆ Characterizes type of laser
 - ❖ Rangefinder, Designator, Beamrider
- ◆ Identifies location of threat
- ◆ Prioritizes threat according to lethality
- ◆ Reports information visually and audibly

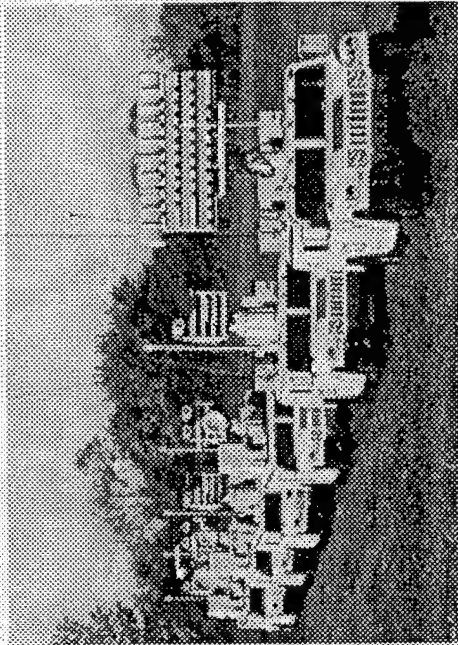
Schedule

	FY98	FY99	FY00	FY01	FY02	FY03
Production						
Fielding						
OH-58D						
AH-64A/D						

5



Aircraft Survivability Equipment Trainer (ASET IV)



Description

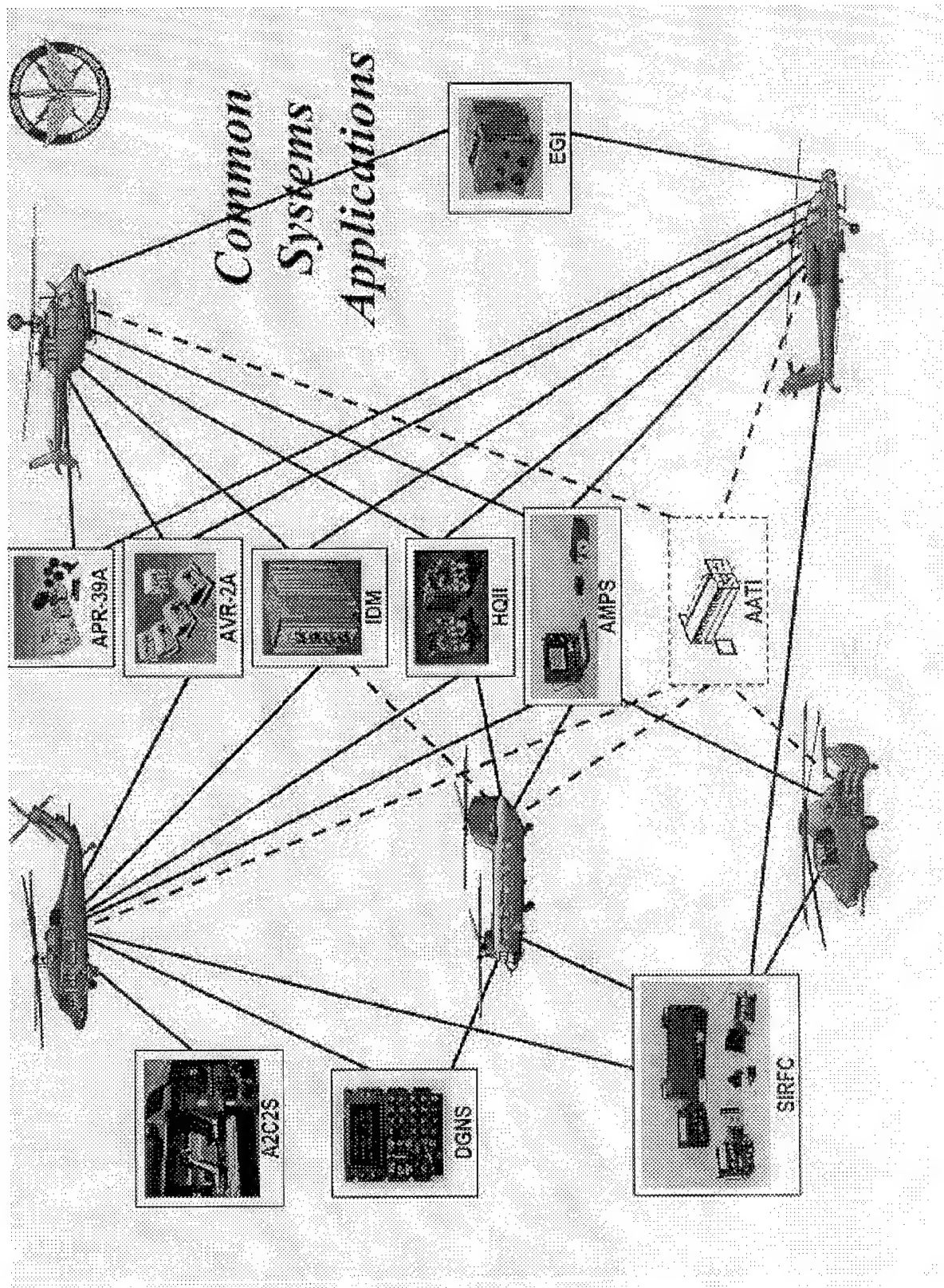
- ◆ Provides advanced aviation threat training
 - ❖ Utilizes tactical mobility and interactive simulation
- ◆ 6 HMMWVs
 - ❖ 5 - Tactical threat vehicles
 - ❖ 1 - C3 vehicle
- ◆ Operates with or without instrumentation

Capabilities

- ◆ Air defense threat emitters for force-on-force training
- ◆ System improvements
 - ❖ Missile threat updates
 - ❖ Night vision enhancement for night training

Schedule

- ◆ Production Complete
- ◆ Fielded to CTCs (JRTC, CMTG, NTC)
- ◆ Field to Home Stations in FY98
 - ❖ Ft Hood/Ft Bragg/Ft Campbell



1249

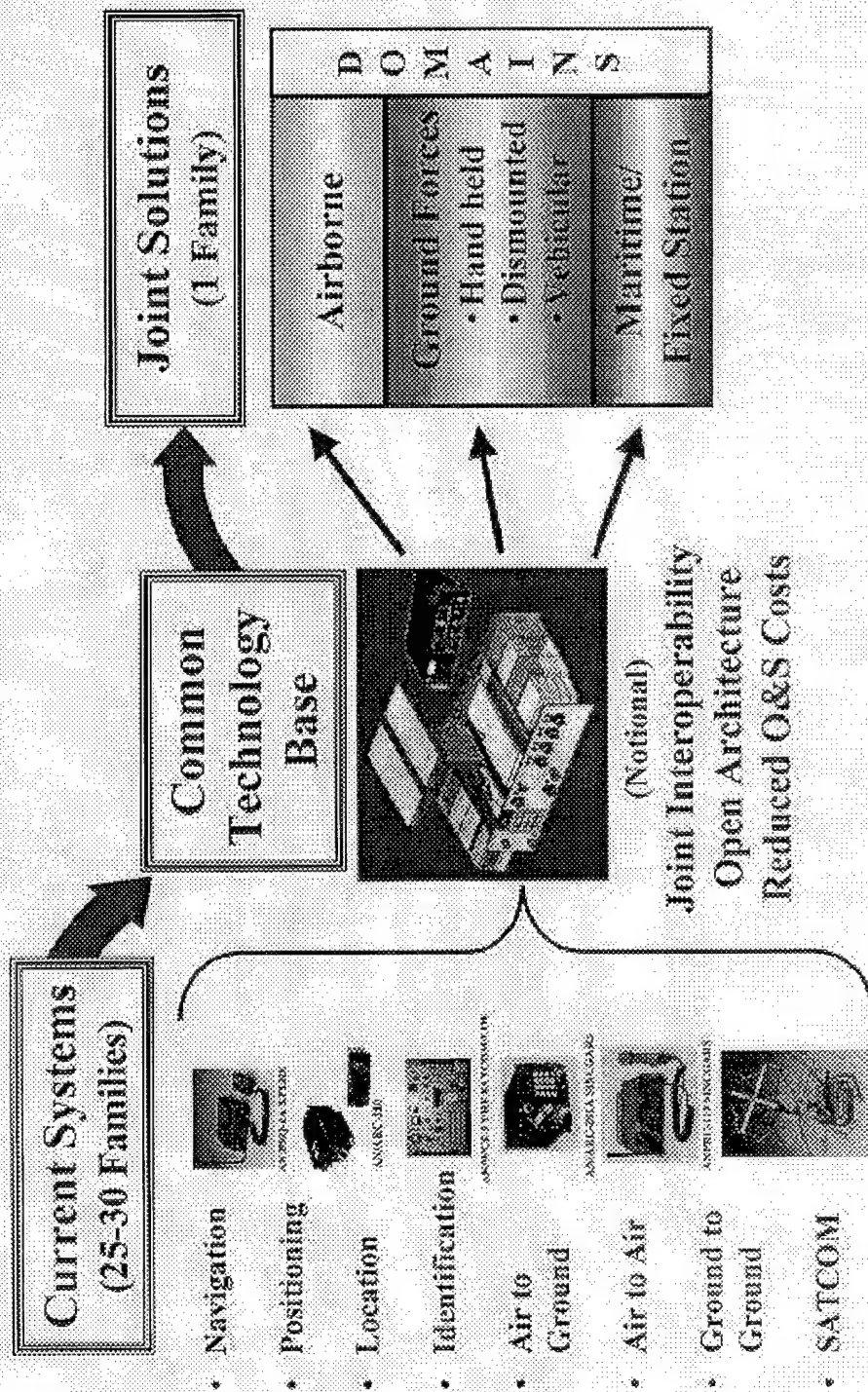


STYLING

2013年12月25日



JTRS Concept





Aviation Requirements



◆ Increment One: FY01

Thesold

- VHF - FM (SINGARS ESIP)
- UHF - AM (HQ II - Joint, Aviation Internal C2))
- VHF - AM (Air Traffic Control)

User requirement is to field increment
One in EX01

❖ Objective:

- EPLRS (TI connectivity)
- UHF DAMA SATCOM (NLOS to TI & Intel)

◆ **Increment Two: FY02**

- *HF ALE (NLOS connectivity)

◆ Increment Three: Beyond FY02

- ## *** Videband, etc. ***



(One Possibility)

-

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Journal compilation © 2007 Blackwell Publishing Ltd



Army
After
Next

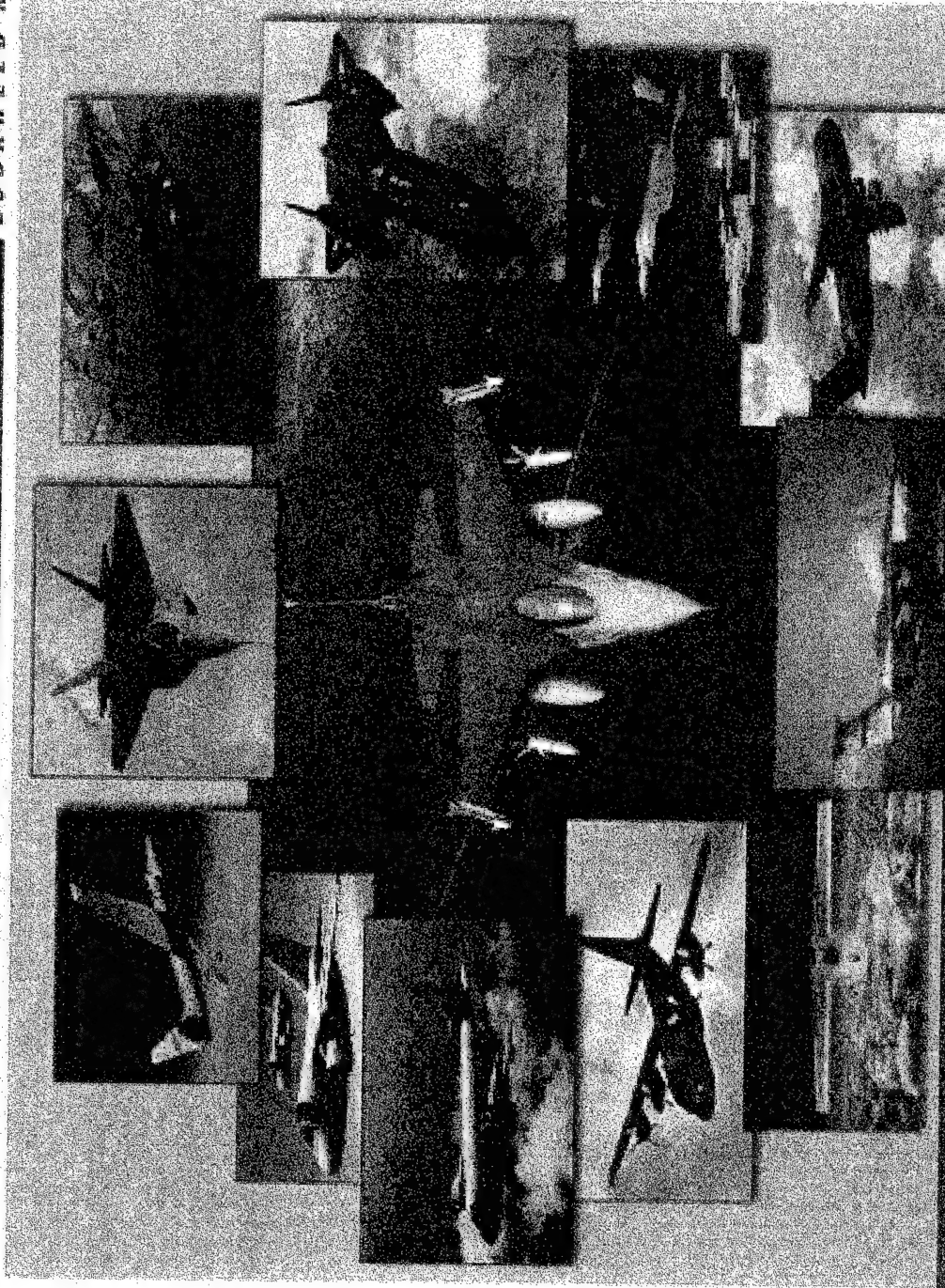




- ◆ Aggressively developing and producing capable and affordable aviation electronics
- ◆ Determining direction for future avionics
- ◆ Significant digitization challenges ahead
- ◆ Significant opportunity to affect the future

Lockheed Martin

LOCKHEED MARTIN



Michael Williams
Manager, Systems Integration & SoS
Lockheed Martin Tactical Aircraft Systems

Contact Me At:
(817) 935-1050 Fax (1212)
michael.a.williams@lmco.com

1255

Ideas of Government & Industry Partnerships

LOCKHEED MARTIN

◆ Business Practices

- ✓ Integrated Product Teams*
- ✓ Acquisition Reform & Single Process Initiatives Via Management Councils*
- ✓ Customer Access to Company Databases*
- ✓ Industry Job Fairs for Displaced Government Personnel*
- ✓ Industry Access to Classified Government Databases
- ✓ Collaborative Benchmarking & Independent Program Reviews

◆ Technology

- ✓ Collaborative Technology Planning*
- ✓ Cooperative R&D Agreements (CRADAs)*
- ✓ Prime, Supplier, and Government CRAD IPTs

◆ Weapon System Development

- ✓ Performance Requirements/Specifications
- ✓ Requirements Visualization Tools
- ✓ Collaborative Weapon System Development Environment
- ✓ Government Participation in Supplier Workshops*

* Currently Implemented Within Lockheed Martin

Partnerships Needed to Meet COTS Challenge

LOCKHEED MARTIN

Military Systems Really Don't Like COTS Components:

- ✓ Vicious Obsolescence Cycle
- ✓ Restricted Operation Environment
- ✓ Lack Of Built-In Testability

But, The Military Can Not Afford "Non-COTS" Solutions.

Or, Can We?

Modified Military Design/Commercial Off The Shelf Implementation (MMD/COTSI)

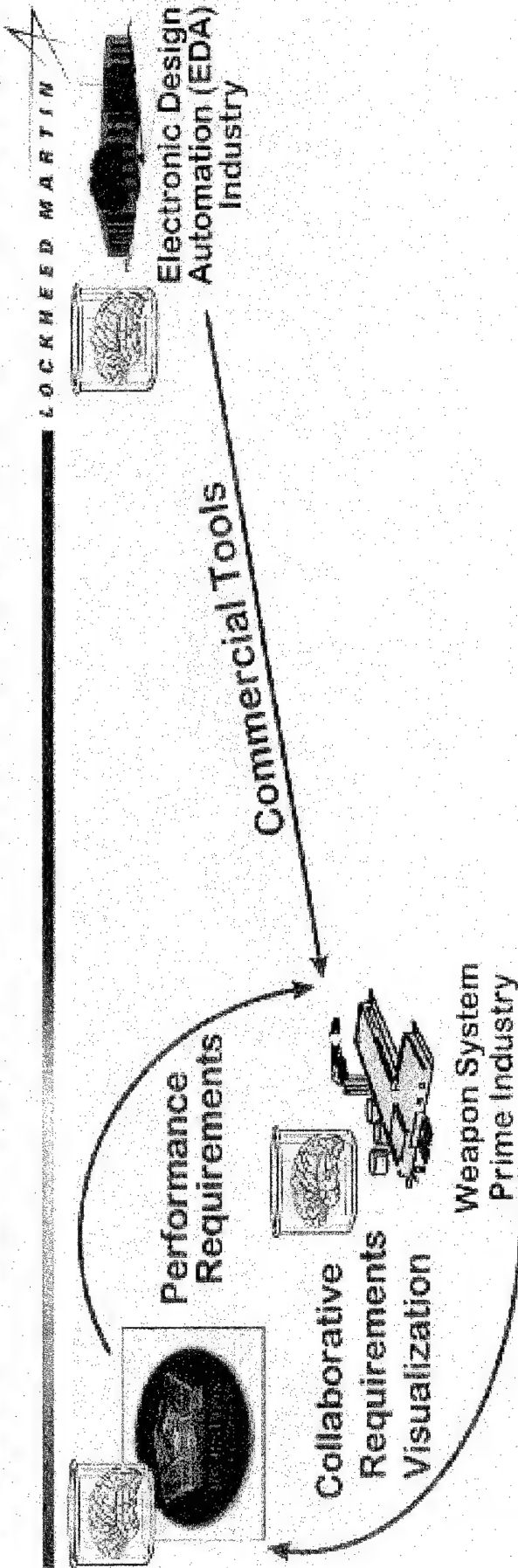
LOCKHEED MARTIN

Problem: A Parts-Based Solution (Any Parts) Ignites an Obsolescence Time Bomb.

Solution: Modify Military Design Processes And Use Commercial Just-In-Time (JIT) Manufacturing.

- ✓ Create Military Designs Which Are Independent of Component Implementation Technology.
- ✓ Stockpile Design, Not Parts.
- ✓ Manufacture In "Then-Year" Technology Using Commercial Foundries (RASSP Example).
- ✓ Leverage Commercial Tools and Processes.
- ✓ Repair and/or Upgrade in "Then Year" Technology With JIT Parts.

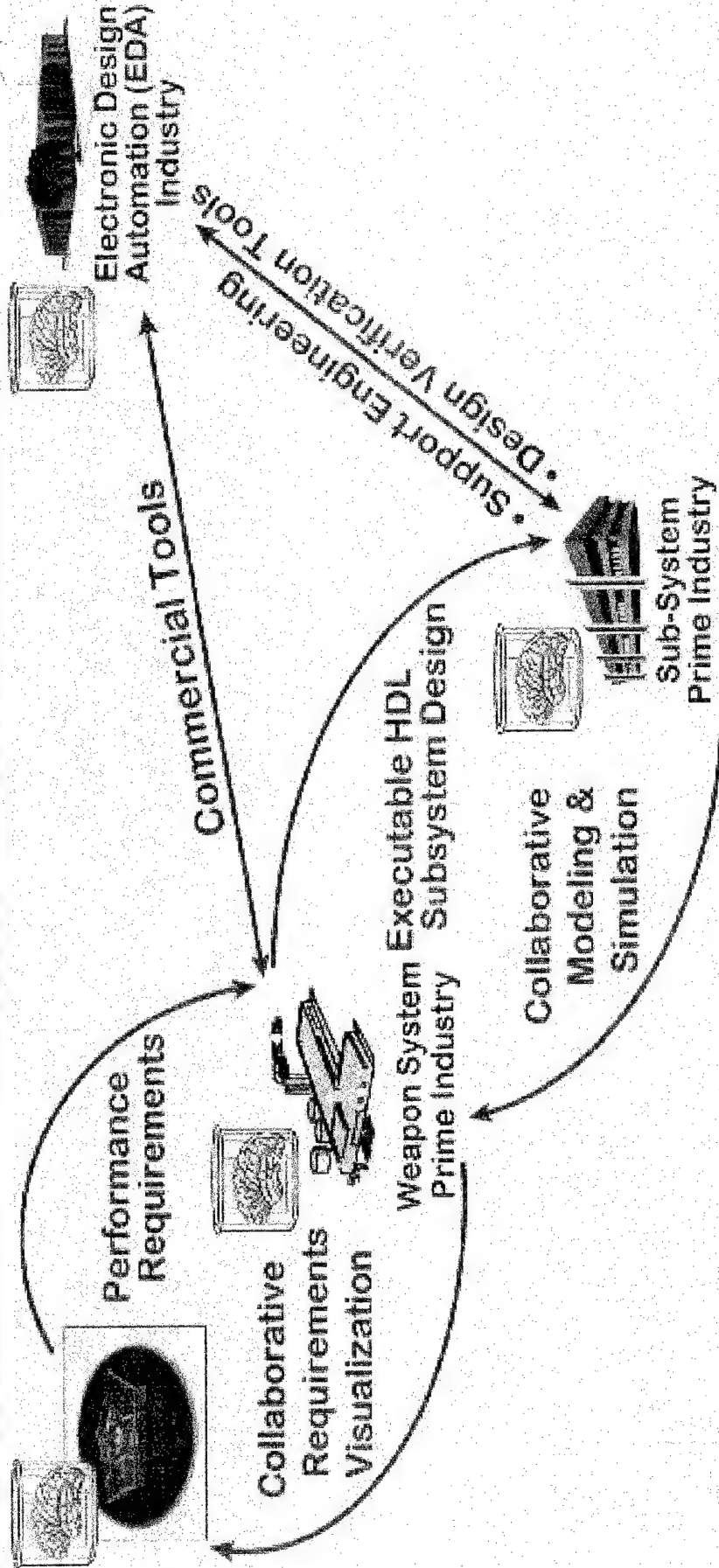
20,000 Foot View of The MMD/COTSI Process



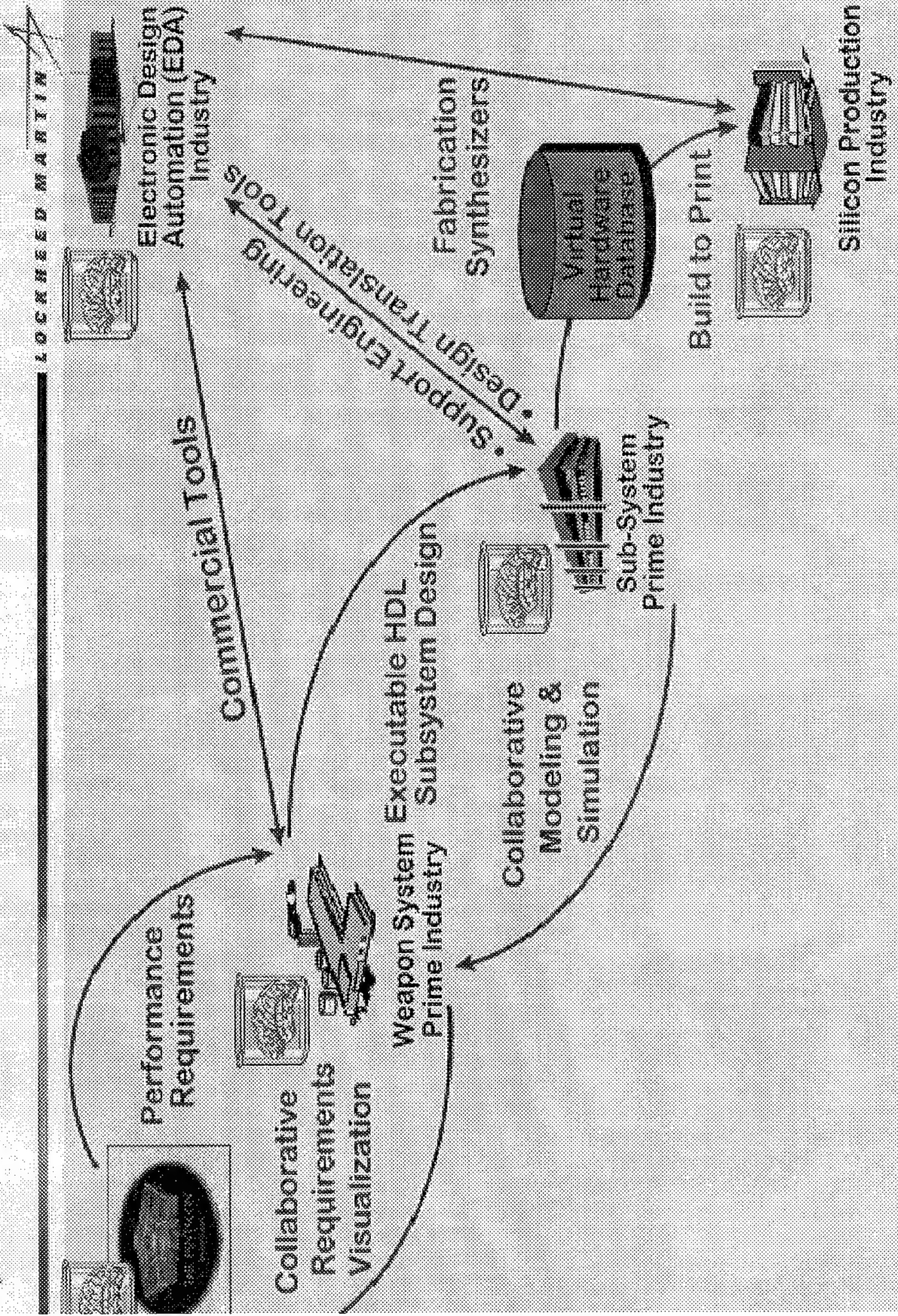
Page

20,000 Foot View of The MMD/COTSI Process

LOCKHEED MARTIN

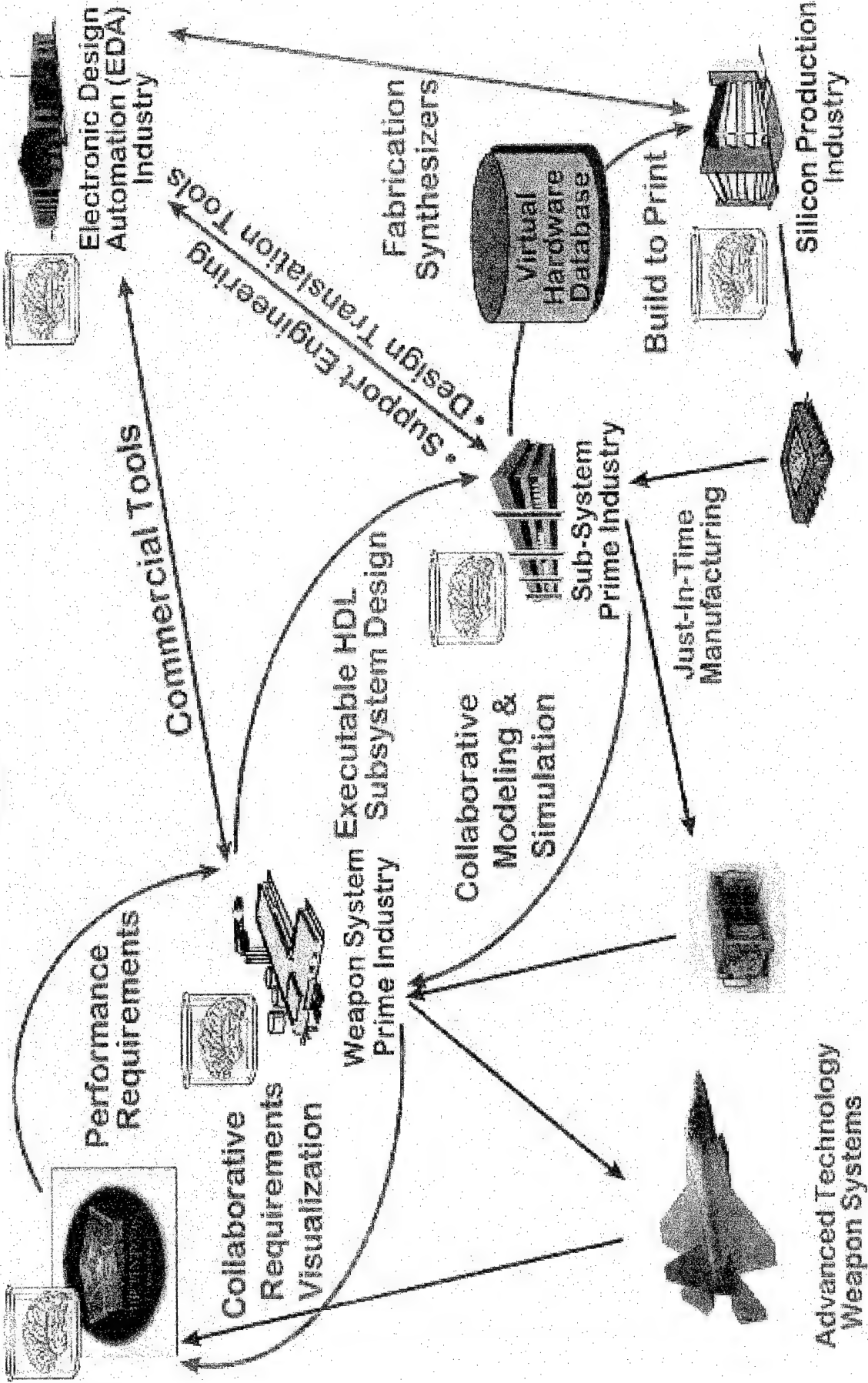


0,000 Foot View of The MMD/COTSI Process



20,000 Foot View of The MMD/COTSI Process

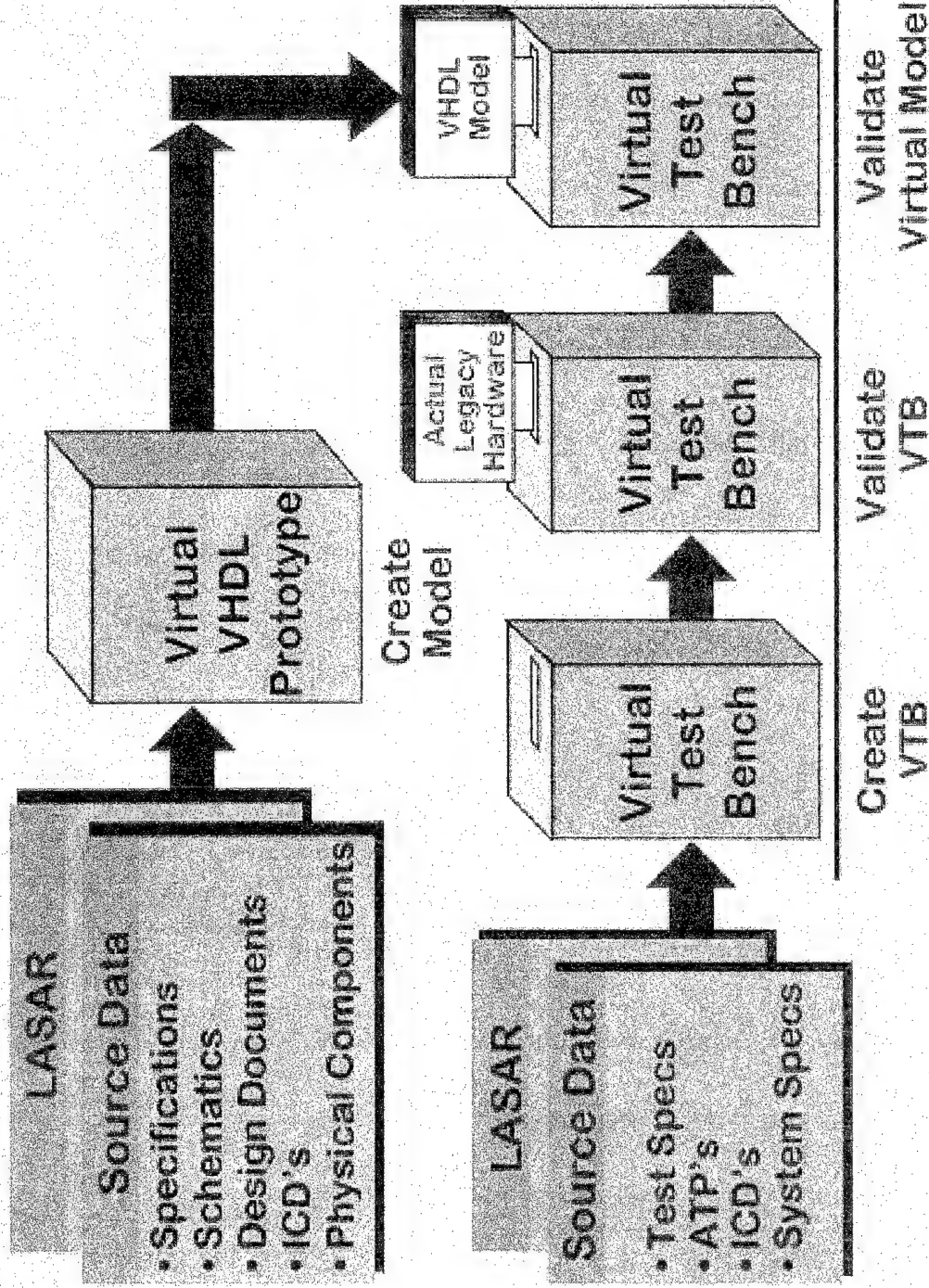
LOCKHEED MARTIN



A View of Our Legacy MMD/COTSI Process

LOCKHEED MARTIN

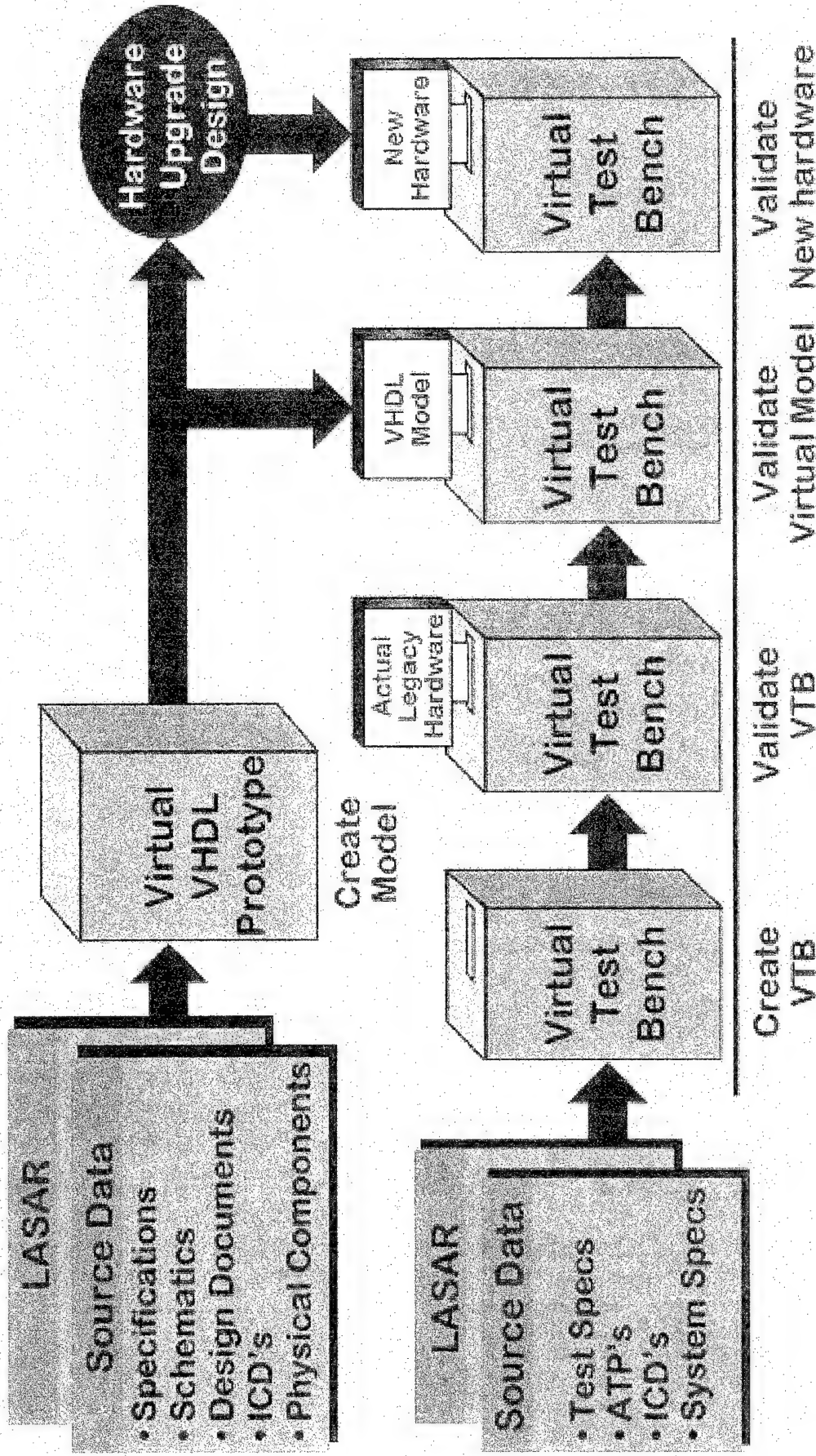
VHDL Model and Test Bench Validation Environment



A View of Our Legacy MMD/COTSI Process

LOCKHEED MARTIN

VHDL Model and Test Bench Validation Environment



Summary

LOCKHEED MARTIN

The Military Can Use COTS (MMD/COTSI)

IF...

- ✓ We Segregate Our Designs From Implementation Technology Obsolescence
- ✓ We Use Commercial Practices, Processes, and Toolsets To Capture Our Designs
- ✓ Our Military Design Provides For Component Testability
- ✓ We Adopt Commercial Practices Such as JIT and Lean Manufacturing
- ✓ We Figure Out How To Do Affordable System Qualification...

This is Not Possible Without Close Partnerships
Between Government and Industry



A F F W E S

Air Force Electronic Warfare Evaluation Simulator

Air Force Plant No. 4 - Fort Worth, Texas



AFEWES Mission



Provide Technical Evaluations of the
Performance of EC Systems and
Techniques in simulated IR/UV/RF
environments.



CAPABILITIES



- RF Countermeasure Evaluation:
 - RF SAMs
 - RF AAMs
 - Airborne Interceptors
- IR Countermeasure Evaluation:
 - IR SAMs
 - IR AAMs
- IR/UV/RF MWS Evaluation



RF SIMULATIONS



- RF OPEN-LOOP SIMULATION
 - Evaluate EC Receivers & Sensors
 - One-way path
 - Dense RF Signal Environment
- RF CLOSED-LOOP SIMULATION
 - 1-v-1 Technique Development & Optimization
 - Two-way Path for Jammer Effectiveness Tests
 - Chaff, Maneuver & Dense RF Environment



RF OPEN-LOOP SIMULATOR



- High-Fidelity RF Environment for Testing RWR & Power Managed Jammer
- Capability of up to 217 Emitters
- Configure to Specific Threats and Operating Area, Includes Terrain Masking
- Stand-Alone or with Closed-Loop Simulator



CLOSED-LOOP SIMULATIONS



SA-2	SPIN SCAN	SA-7A,B	GUN DISH
SA-3	JAY BIRD	SA-9	FLAP WHEEL
SA-4	FOX FIRE	SA-13	LONG TRACK
SA-5M	FLANKER	SA-14	WILD CARD
SA-6M	FULCRUM	SA-16	TACAN
SA-8	FOXHOUND	SA-18	IFF
	REDEYE	STINGER	C3 (4,8)



NEAR TERM
IMPROVEMENTS
&
MODERNIZATION



RF CLUTTER

1QFY99

SA-10

4QFY98

IR SAM

1QFY99



UNIQUE ADVANCES IN HARDWARE-IN-THE-LOOP



IR AA-11

4QFY98

JMASS-6

1QFY99

UV/IR MWS

2QFY99

SA-12

4QFY99

1999



A FEWES LINKING



Evaluate the utility of using electronically linked test assets for EW technical evaluations.



LINKING OVERVIEW



- MILESTONTES (1985 - 1997)
- LINKING 1998
- LINKING 1999
- SUMMARY



LINKING MILESTONES



- 1985 AFEWES & FLIGHT SIM LAB (FSL)
- 1988 AFEWES/FSL AIR WARFARE CENTER TACTICS
DEVELOPMENT
- 1991 AFEWES/REDCAP/EMTE DEMONSTRATION
- 1995 AFEWES/FSL DATA LATENCY
- 1996 T&E ENGINEERING PROTOFEDERATION
- 1997 THREAT SIMULATION LINKING ACTIVITY



LINKING 1998



**JOINT ADVANCED DISTRIBUTED SIMULATION
ELECTRONIC WARFARE (JADS-EW)**

- **PURPOSE: DETERMINE UTILITY FOR D/OT&E**
- **SCOPE: BASELINE AT OAR
REPLICATE OAR IN JADS ENVIRONMENT**
- **OBJECTIVES: MEASURE PERFORMANCE
ESTABLISH VARIABILITY
CORRELATE RESULTS
QUANTIFY EFFECTS**



LINKING 1998



JOINT ADVANCED DISTRIBUTED SIMULATION ELECTRONIC WARFARE (JADS-EW)

- PHASE I: OAR BASELINE (AFEWES, OAR, JTF) 4/98
- PHASE II: DSM (AFEWES, ACETEF, JTF) 10/98
- PHASE III: (AFEWES, ACETEF, JTF) 5/99



LINKING 1999

AFFTC AND NAWC LINKED MULTI-FACILITY ELECTRONIC WARFARE EXERCISE

- OSD FOUNDATION INITIATIVE
- AFOTEC IS TEST SPONSOR
- PURPOSE: CONDUCT REAL-TIME MISSION LEVEL
UAV TEST WITH HLA LINKS TO USAF &
USN GROUND & OAR TEST ASSETS



LINKING SUMMARY



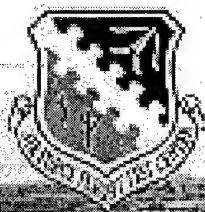
- 6 MILESTONES (1985 - 1997)
- LINKING 1998 (JADS-EW)
- LINKING 1999 (AFFTC/NAWC)



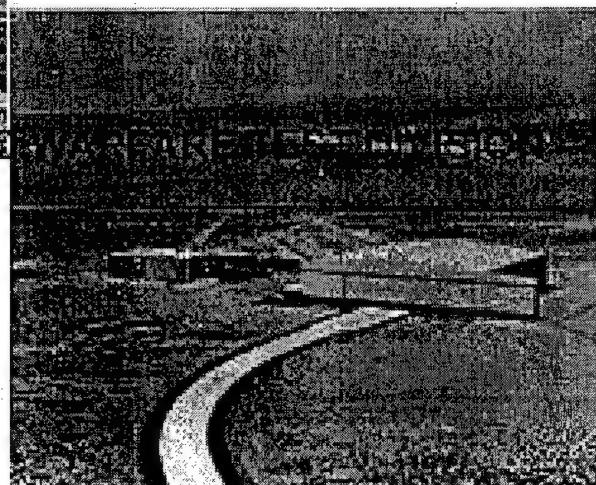
SUMMARY



- AFEWES provides a high density signal environment, in a secure facility, for testing ECM systems and techniques.
- DT&E/OT&E in IR/UV/RF environments.
- Air-to-air and surface-to-air threat simulations.
- Local and distributed scenarios (HLA)



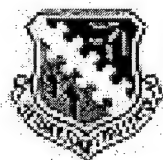
EDWARDS AFB AVIONICS TEST AND INTEGRATION COMPLEX



LT COL RANDY
KELLY, USAF
CHIEF
412 TW/WW

850-277-5404

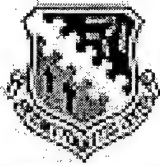
Kelly, r.k. % ewa / @ m h s . e / a r . a f . m i l



PURPOSE



- PROVIDE AN OVERVIEW AND
UPDATE OF THE GROUND TEST
FACILITIES AT EDWARDS AFB's
AVIONICS TEST & INTEGRATION
COMPLEX



OVERVIEW

- **BACKGROUND:** How has the environment changed?
- **GROUND TEST FACILITIES AT THE ATIC:** A quick overview.
- **THE FUTURE GROUND TEST ENVIRONMENT:** "Virtual Boy"* in the attic?

inter

* Registered trademark of Nintendo 2



BACKGROUND

- Evolutionary, and revolutionary aircraft changes
 - From performance & flying qualities is ONLY problem, to -
 - Integrated avionics is BIGGEST problem
- EW systems experienced similar change
 - From, observer in "lighter than air" craft, to -
 - Complex "do it all" EW systems
 - Detect, identify, and provide situational awareness
 - Determine appropriate actions
 - Initiate countermeasures & cue maneuvers



BACKGROUND THE "TEST PROCESS"



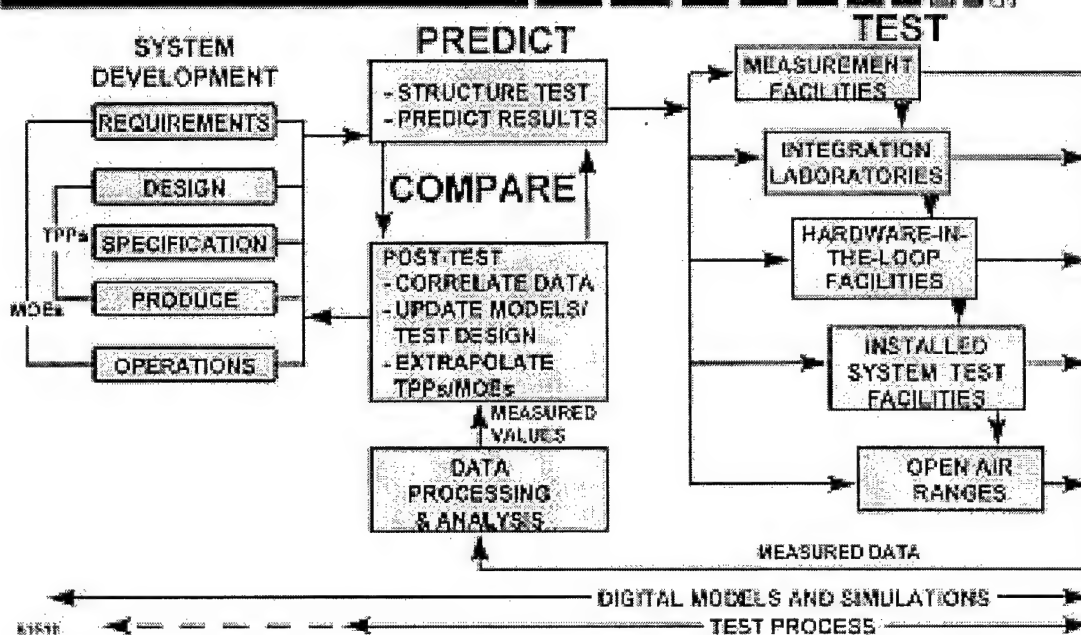
- The standard "Fly - Fix - Fly" cycle
 - Simple; plan, fly, fix, fly, fix, fly, fly\$
- The recursive but disciplined "Predict - Test - Compare" cycle
 - Predict using models & simulation tools
 - Test using appropriate facility
 - Compare to predictions
 - Feedback results to mitigate risk and improve models (plus lower regression test reqmts)

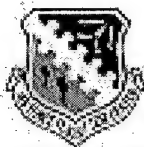
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AVIONICS & EW T&E PROCESS





IMPORTANT REMINDERS



- M&S and ground test facilities are not replacements for flight test
- Generally, no single facility can provide the entire answer
- Facility decisions depend on risk management strategy, program phase, \$\$\$, and time
- Strong synergy in co-located facilities

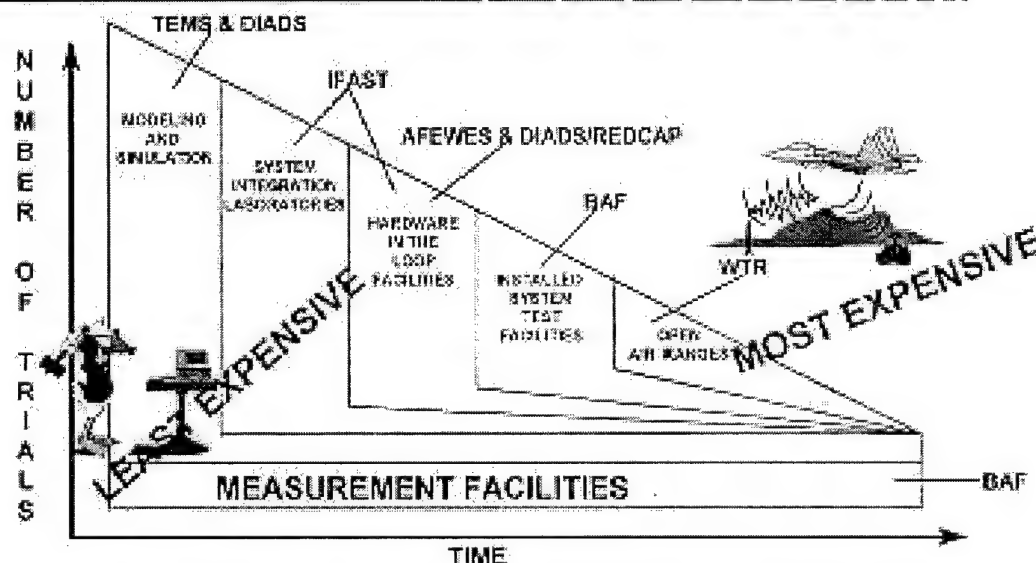


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AFFTC FACILITY HIERARCHY



RELATIVE USE OF T&E RESOURCE CATEGORIES

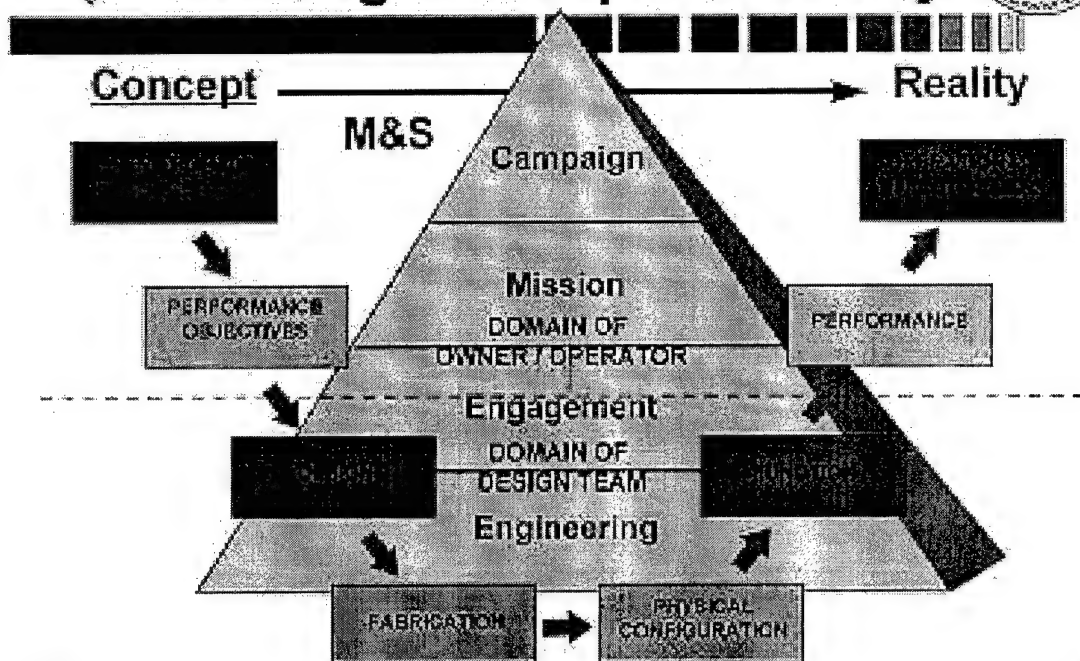
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M&S

Linking Concept to Reality

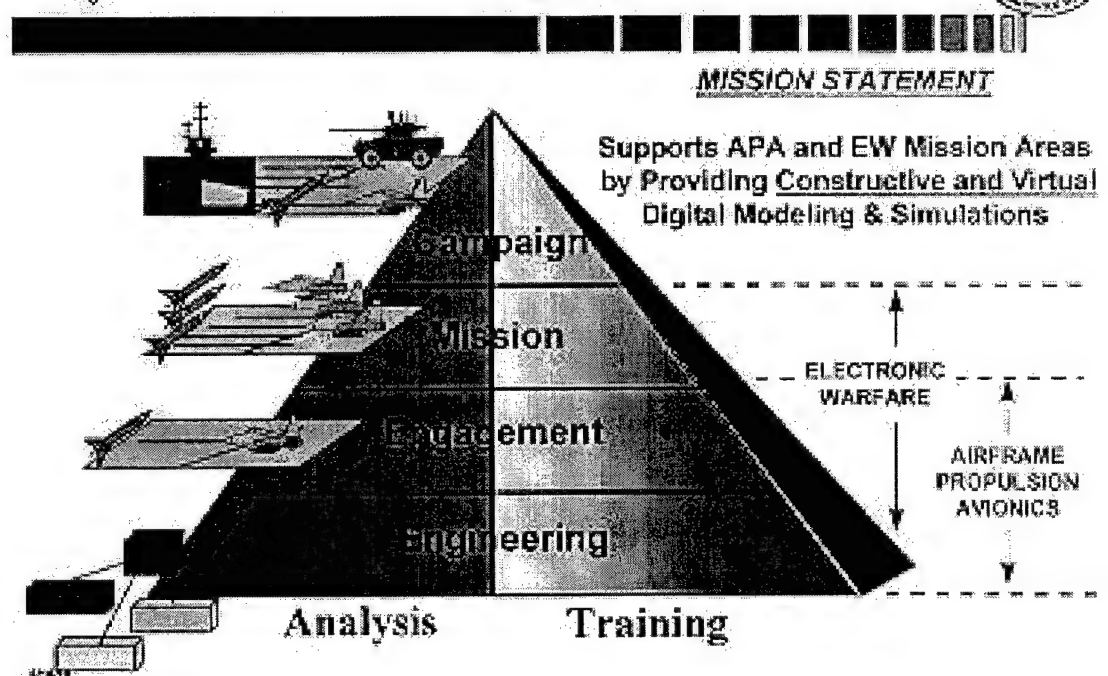


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8



CAPABILITIES TEMS





CAPABILITIES TEMS



CONSTRUCTIVE SIMULATIONS

■ THUNDER Campaign

- Multi-Day Campaign; Theater Level
- Force-on-Force; Air-Land Battle

■ SUPPRESSOR

- Air Superiority/SEAD; Mission Level
- Many-vs-Many; Air-Land Battle

Mission

■ DIADS

- Enemy IADS; Mission Level
- Many-vs-Many; Air-Land Battle

■ ESAMS

- Survivability; Engagement Level
- One-vs-One; Air-Land Battle

Engagement

■ JMASS

- Simulation Architecture
- Engineering and Engagement

Engagement Engineering

611541

31



CAPABILITIES TEMS



VIRTUAL SIMULATIONS, MODELS, & COCKPITS

■ AERODYNAMIC

■ ENGINE

■ EQUATIONS OF MOTION

■ TARGETS

■ THREATS

■ INTEGRATED AIR DEFENSE SYSTEMS

■ FLIGHT CONTROL SYSTEMS

■ AIRCRAFT SYSTEMS

■ ATMOSPHERIC

■ AVIONICS COCKPIT DISPLAYS

■ ELECTRONIC WARFARE DISPLAYS

■ MISSILE FLY-OUTS

■ B-1B, F-16, F-22, TES generic cockpit

611541



CAPABILITIES

TEMS - STANDALONE DIADS



- Air Defense Ops Center (ADOC)
- 4 Sector Ops Centers (SOC)
- 15 Integrated Ops Centers (IOC)
- 20 AAA Command Centers
- 75 Radar Posts
- 250 EW/HF/Acq Radars (100 active)
- Fire Control Radars
 - 40 Med/Long Range SAM, 10 Active
 - 100 Short Range SAM, 10 Active
 - 160 AAA, 10 Active
- 200 AIs, 40 Active, 10 Types
- 200 Penetrators, 60 Active, 10 Types
- 5 SAM Types
- 5 AAA Types

471178

15



APPLICATIONS

TEMS



VIRTUAL SIMULATOR TESTING "Laundry List"

- ENVELOPE EXPANSION
- FLIGHT CONTROL FAILURE
- HUMAN FACTOR INTERFACE STUDIES
- EMERGENCY PROCEDURES
- SENSITIVITY ANALYSIS
- MISSION REHEARSAL
- SYSTEM FAMILIARIZATION
- CONTROL SYSTEM FUNCTIONAL TESTING W/ FAILURE STATES
- ANOMALY INVESTIGATION
- EW BLUE/RED OITL
- MANEUVER PRACTICE AND DEFINITION
- AIRCREW & ENGINEER TRAINING
- ACCIDENT INVESTIGATION
- FLIGHT SAFETY EVALUATIONS
- EFFECT OF STORE CARRIAGE
- STORE SEPARATION AND WEAPONS DELIVERY ACCURACY
- CREW RESOURCE TRAINING
- ENGINE TRANSIENTS AND AIRSTARTS
- ANALYSIS AND TRAINING

471178

15/10



CAPABILITIES TEMS



VIRTUAL SIMULATOR ADVANTAGES

- RAPID RECONFIGURATION
- REAL-TIME MODIFICATION OF ANY SIMULATION PARAMETER
- INPUT ACTUAL FLIGHT TEST DATA
- RECORD PILOT INPUTS FOR REPEATABLE MANEUVERING TARGETS
- TAILORABLE VISUAL SCENES 20 - 360 DEGREES
- LINKABLE WITH IFAST OR DIADS FOR HARDWARE-IN-THE-LOOP

071002

17



CAPABILITIES IFAST



FACILITY DESCRIPTION

- AVIONICS HARDWARE-IN-THE-LOOP (HITL) AND SYSTEM INTEGRATION LABS (SILs)
- 6 SHIELDED SECURE TEST BAYS
 - FOV of flightline & range
 - Collocation w/CTF's, shared assets
 - Aircraft power, cooling
- F-16: 1 TEST BAY (7,000 ft²)
- F-15: 1 TEST BAY (7,000 ft²)
- B-1B: 1.5 TEST BAYS (10,500 ft²)
 - Offensive and defensive
- F-22: 2 TEST BAYS (21,000 ft²)



071001

02/91



CAPABILITIES IFAST



■ AIRCRAFT AVIONICS

FIRE CONTROL	RADAR (APG-68/70)
STORES MANAGEMENT	UP-FRONT CONTROLS
HEADS-UP DISPLAY	IDM
MULTIFUNCTION DISPLAY	RADAR WARNING RECEIVER

■ AVIONICS LRU COMMUNICATION

F-16	F-15	B-1B	F-22 (FALL 98)
------	------	------	----------------

■ SENSOR SYSTEM INTEGRATION

FCR	RWR	NVP	TGP
-----	-----	-----	-----

■ WEAPONS SYSTEM INTEGRATION

AIM-9	AIM-120	AGM-85	HARM	SLAM
-------	---------	--------	------	------

■ NAVIGATION SYSTEM INTEGRATION

INS	GPS	EGI
-----	-----	-----

■ ECM POD CHECKS (ALQ-167 inside, any outside)

13



HITL APPLICATIONS IFAST



- SUBSYSTEM OR SUITE
SPREAD BENCHES

- PROTOTYPE/PRE-PRODUCTION/
PRODUCTION

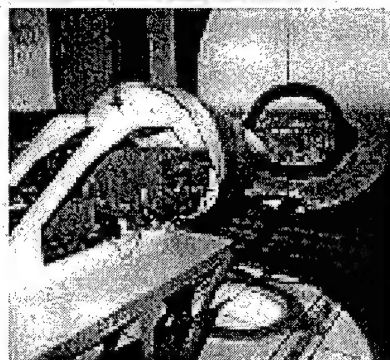
- BRASSBOARD/BREADBOARD

- OPERATIONAL SOFTWARE IN
TARGET PROCESSOR

- MAY INCLUDE THREAT REPRESENTATIVE HARDWARE /
SW / SIGNALS

- DYNAMIC AERO AND SIGNALS ENVIRONMENT

- STORES MAY BE INCLUDED



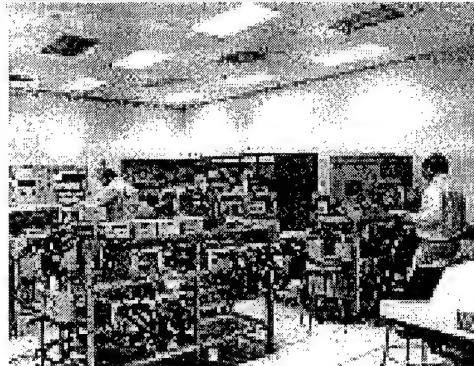
AT&T



SIL APPLICATIONS IFAST



- TESTING WITHIN INTEGRATED AVIONICS "BACKBONE" (F-16, F-15, B-1B, [F-22])
- DEVELOPMENTAL OR TEST PURPOSES
- SOFTWARE AND HARDWARE INTEGRATION
- TESTING HUMAN AND SYSTEMS/VEHICLE INTERFACES
- MAY INCLUDE OTHER WEAPON SYSTEMS
- USUALLY INCLUDES OTHER ON-BOARD SUB-SYSTEMS (OR HYBRID/EMULATIONS)
- PROTOTYPING TECHNOLOGIES (ADVANCED CONCEPT TECH DEMOS OR OTHER DEMOS WITH REAL HARDWARE)



01144

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A FEWES FACILITY



- HARDWARE-IN-THE-LOOP FACILITY
 - EC EFFECTIVENESS
 - OPEN AND CLOSED LOOP
- SAM, AAA, AND AIRBORNE INTERCEPTOR RF THREATS
- INFRARED TEST LABORATORIES
 - SEEKER DEVELOPMENT
 - IRCM DEVELOPMENT
- LOCATED AT AF PLANT 4, FT WORTH TX

01144

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CAPABILITIES BAF



FACILITY DESCRIPTION

■ WORLDS LARGEST INSTALLED SYSTEM TEST FACILITY (ISTF) & MEASUREMENT FACILITY (MF)

- 264ft x 250ft x 70ft (door 200ft x 68ft)
- PLUS SMALL EMI/EMC TEST ROOM



■ LARGE CENTRAL TURNTABLE

- 80ft DIAMETER, 250,000 lbs CAPACITY
- +/- 180 DEG ROTATION (0.1-0.8 DG/SEC)

■ 2 HOISTS FOR SMALL/MEDIUM AIRCRAFT

- 80,000 lbs CAPACITY EACH, MAN-RATED

11141

23



CAPABILITIES BAF



■ AIRCRAFT POWER & UTILITIES

■ FREE SPACE RADIO FREQUENCY (0.5-18 GHz)

- > 100dB ATTENUATION INTRINSICALLY
- RAM ADDS ADDITIONAL ATTENUATION
- APPROX 10^6 ft³ QUIET ZONE

■ THREAT GENERATION (CEESIM 8000)

- LAND, SEA, AIRBORNE THREATS
- 640 SIMULTANEOUS SIGNALS AT DIGITAL LEVEL
- 100 SIMULTANEOUS SIGNALS GENERATED AT RF
- TAILORABLE PARAMETERS CORRELATING WITH
OAR THREATS

11141

1114



CAPABILITIES



■ FREE SPACE GPS STIMULATORS

- FULL 24 SATELLITES
- POSITION ANYWHERE, ANYTIME, ANY VELOCITY

■ JAMMER (AN/ULQ-23)

- 60 FUNCTIONS
 - NOISE DECEPTION
 - COMB NOISE/DECEPTION 8-11 GHz
 - VELOCITY GATE STEALER RANGE GATE STEALER
- SUPPORT CAPABILITY FOR OTHER JAMMER PODS

■ ANTENNA PATTERN MEASUREMENT SYSTEM

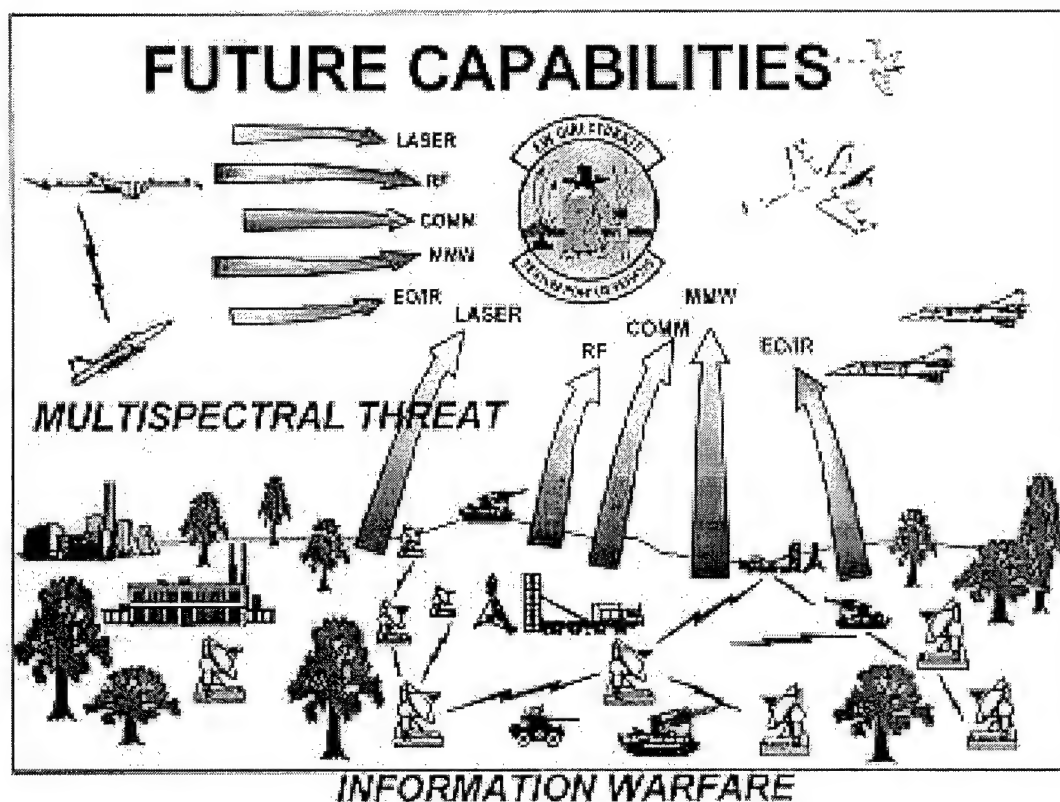
■ NAV AND AIR DATA COMPUTER DATA STIMULATION



APPLICATIONS



- ANTENNA PATTERNS
- APERTURE AIRFRAME INTERACTIONS
- MULTI AIRCRAFT INTEROPERABILITY
- AOA ACCURACY
- ECM AND ECCM RESPONSE
- MIN DISCERNIBLE SIGNAL
- THREAT ID
- SYSTEM RESPONSE TIME
- POLARIZATION TESTING
- SECURE EMISSIONS
- UNINTENTIONAL EMISSIONS
- ERP MEASUREMENT
- EMITTER DETECTION, ID AND SYSTEM PERFORMANCE
- TARGET RESOLUTION/ SIGNAL CORRELATION
- MULTI-EMITTER SCENARIO PERFORMANCE
- ANOMALY INVESTIGATION
- EMI/EMC, RF COMPATIBILITY
- SUT CHARACTERIZATION
- RCS/IMAGING
- GPS JAMMING



FUTURE ATIC CAPABILITIES



- DIGITAL IADS-REDCAP (DIADS-REDCAP)
 - ON-SITE REDCAP OITL EQUIPMENT
- ELECTRONIC COMBAT INTEGRATED TEST (ECIT) UPGRADES
 - RF CORRELATED EW, CNI, AND RADAR THREAT/TARGETS
 - THREAT/TARGET SIMULATORS TIED TO IFAST
 - MULTISPECTRAL CORRELATED THREATS/TARGETS
 - HIGH FIDELITY IR SCENE (TARGET) GENERATOR
 - LINKAGES TO CO-LOCATED ATIC FACILITIES: BAF, IFAST, TEMS, DIADS
- POD MOUNTED SEEKERS
- AIR WARFARE MISSION SIMULATOR (AWMS)



DIADS-REDCAP

REDCAP CAPABILITY LEGACY



- REDCAP AT BUFFALO NY WAS HITL IADS TESTING CENTER
- BRAC-95 DISESTABLISHED REDCAP
- CAPABILITIES BEING RE-ESTABLISHED AT AFFTC (ATIC) IN FY 99
 - ALL DIGITAL MODEL OF REDCAP (DIADS)
 - MAN-IN-THE-LOOP
 - LINK WITH OPEN AIR RANGE FOR HARDWARE-IN-THE-LOOP

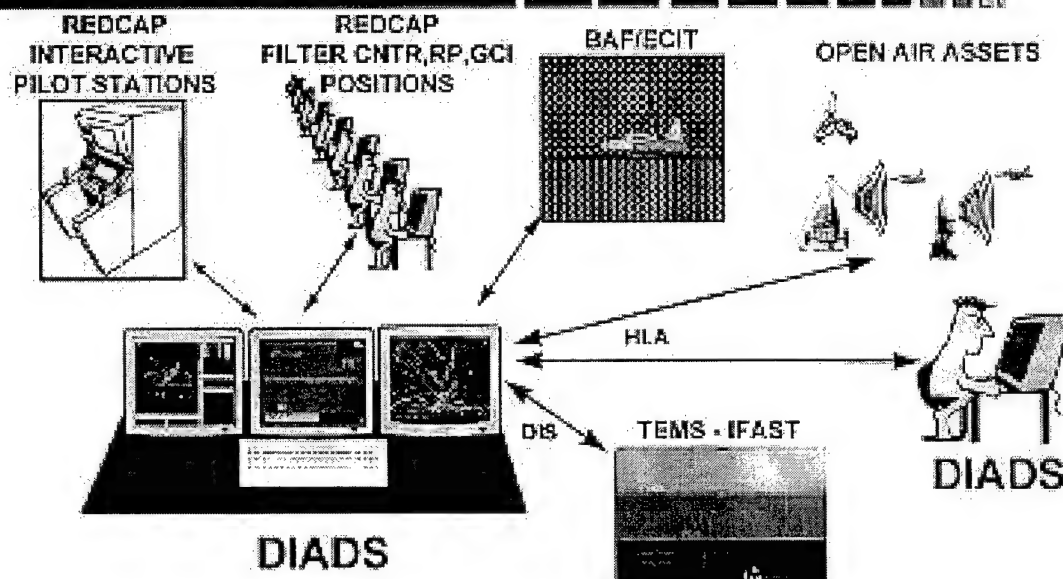
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DIADS - REDCAP

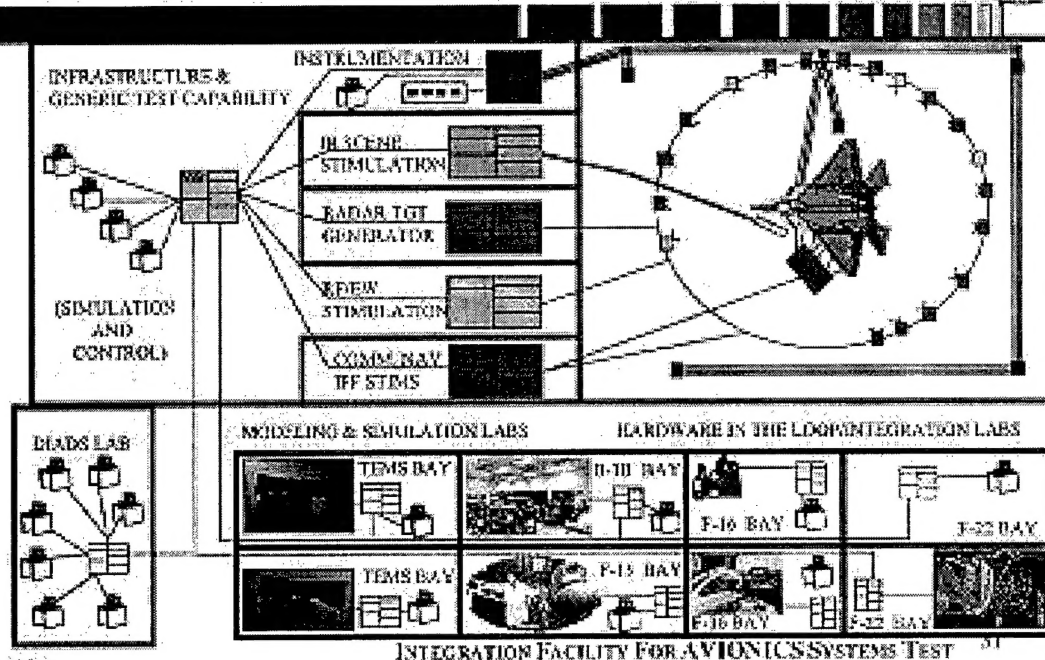
Integrated Real Time Operation



4-456



ECIT FUNCTIONAL LAYOUT



07/1/98

31



CAPABILITIES ECIT



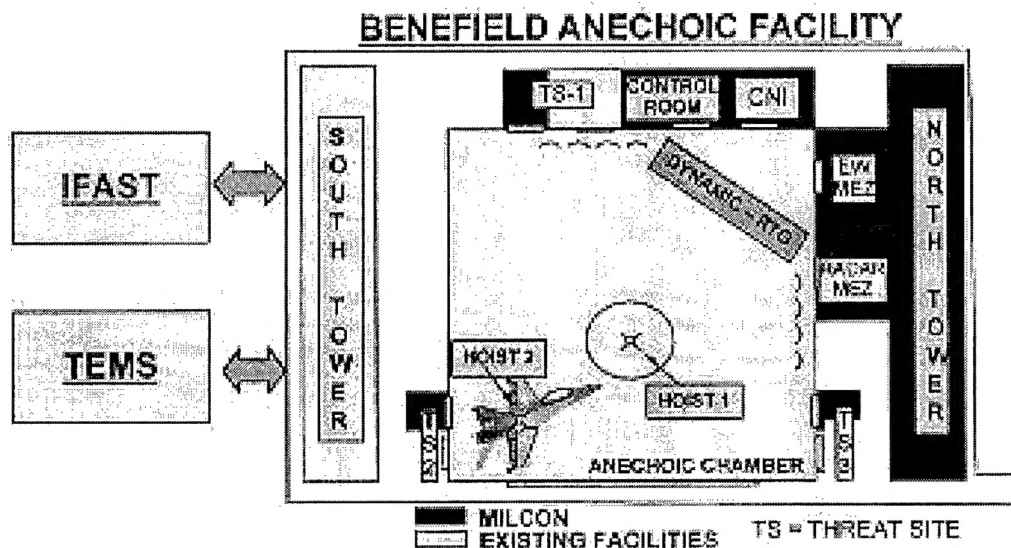
THREE PHASE APPROACH

- PHASE 1: FY99
 - INFRASTRUCTURE & GENERIC TEST CAPABILITY
 - HIGH DENSITY-REALISTIC RF ENVIRONMENT
- PHASE 2: FY00
 - CNI STIMULATION
 - RADAR TARGET GENERATION
 - RF CORRELATED EW, CNI, RADAR THREATS/TARGETS FOR STRESS TESTING
- PHASE 3: FY01
 - EO/IR TARGET GENERATION
 - MULTISPECTRAL CORRELATED THREATS/TARGETS FOR SYSTEM CORRELATION AND DATA FUSION EVALUATION

07/1/98



ECIT PHYSICAL LAYOUT



10/10/04

23



SUMMARY

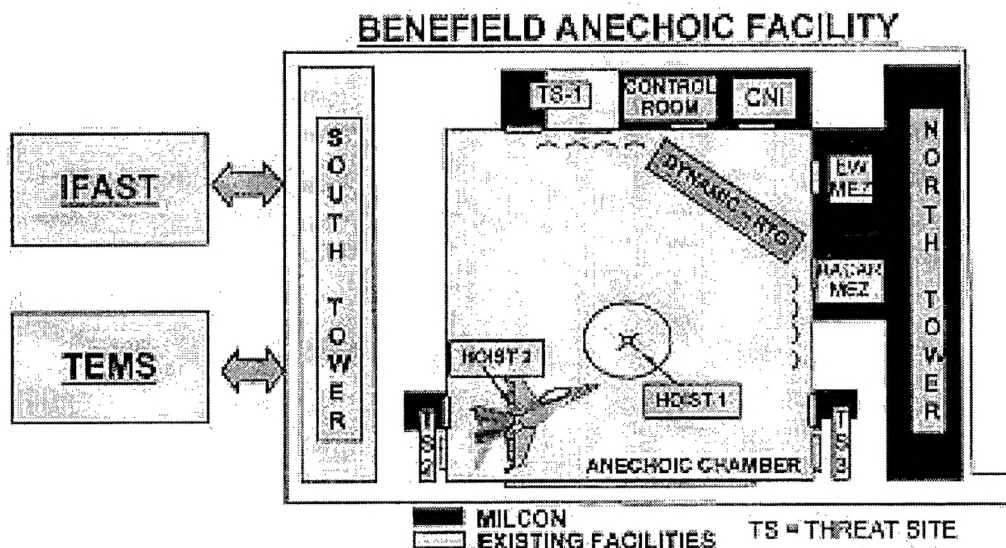


- Avionics & EW test process are disciplined recursive approach to testing that is "tailored" to your risk management strategy
- Full spectrum of ground facilities available at AFFTC to support risk mitigation
- Ground test facilities complement OAR test capabilities
- Constructive M&S through virtual DIADS and campaign level simulations
- Avionics Integration Labs F-15, F-16, F-22, B-1B
- Large Anechoic Chamber for RF & electromagnetic tests

10/10/04



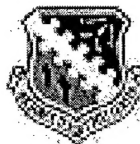
ECIT PHYSICAL LAYOUT



DESIGN CONCEPT

AFRL

33



SUMMARY



- Avionics & EW test process are disciplined recursive approach to testing that is "tailored" to your risk management strategy
- Full spectrum of ground facilities available at AFFTC to support risk mitigation
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- Constructive M&S through virtual DIADS and campaign level simulations
- Avionics Integration Labs F-15, F-16, F-22, B-1B
- Large Anechoic Chamber for RF & electromagnetic tests

AFRL

1300



ATIC POINTS OF CONTACT



- SINGLE-FACE-TO-CUSTOMER: RALPH NELSON OR BOB HANLON
 - DSN 525-9250/Commercial (805) 275-9250
- EW: (EW T&E Process) DICK MCQUILLAN
 - DSN 525-7615/Commercial (805) 275-7615
- EWW: LT COL RANDY KELLY or RICK STRAMA
 - DSN 527-5404/Commercial (805) 277-5404
- EWWA (BAF): PAT DUBRIA
 - DSN 527-5680/Commercial (805) 277-5680
- EWWI (IFAST): SHEILA FORRETTE
 - DSN 527-6589/Commercial (805) 277-6589
- EWWs (TEMS&DIADS/REDCAP): JOE PIOTROWSKI
 - DSN 527-7676/Commercial (805) 277-7676
- OL-AB (AFEWES): LT COL JAIME SILVA
 - DSN 838-5856/Commercial (817) 763-4856

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